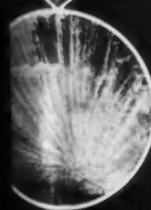


# CHEMISTRY



NOVEMBER  
1946



Gas From the Earth	DEC 17 1946	1
Looking For Oil		8
Petroleum Chemicals Aid the Farmer		12

## Back Cover: Chemical Farm

Gasoline Tailored to Fit	13
Industrial Apparatus: Melt	21
Chemical Things To Do:	
Etch Metal With Flashlight Cell	22

## Chem Quiz:

How Long Has This Been Going On?	24
No More "Mad Hatters"	25
American Universities Overseas	27
Ingenious, a Picture Story	31
From Lack of Oxygen	36
Chapter From a Chemist's Life	37

## For the Home Lab:

Fragrance of Cinnamon	40
How Organic Compounds Are Built	42
Patents in Chemical Fields	46
Engineered Fabrics	51

## Classic of Chemistry:

Elements Yielded by Yttrium	57
Hints for the Chem Lab	62

## Editorial:

The Scientist Meets the World  
Inside Front Cover

25¢

## *The Scientist Meets the World*

► POLITICS AND SCIENCE can no longer pretend to be strangers. When they were introduced, violently, by the atomic bomb, the smallest thing in the universe became suddenly the biggest, and the most important question to mankind became, "Can we afford to go on quarrelling with our neighbors in the time-honored way, or isn't it about time we tried some of the 'charity toward all' ideas we have been talking about so long?"

The scientists today stands with reluctant feet at the door of his ivory tower, somewhat appalled by the world outside. Here he sees groups of people with the same aims struggling against each other in the name of progress, to their mutual nullification. There he sees labor-capital-management sulking like small boys and throwing monkey-wrenches into each other's barely functioning machinery. Again he sees those who claim to be the world's spiritual leaders conducting campaigns of hate, apparently to promote a series of "holy wars." Just over the horizon, starving men are destroying each other's food supplies, to the further impoverishment of this already too-small planet.

What hope does the scientist see for remedying this ridiculous state of affairs? Shall he toss his objective training to the winds and plunge into the fight, satisfied that, so long as his side possesses the only atomic bombs it must automatically be in the right? Shall he throw the power of his superior technical knowledge on the side from which he can get the most money, regardless of individual rights? Or is it just barely possible that he can bring out of the laboratory the rational, impersonal attitude which has accomplished so much in his own field, and apply it to clearing up some of the world's troubles?

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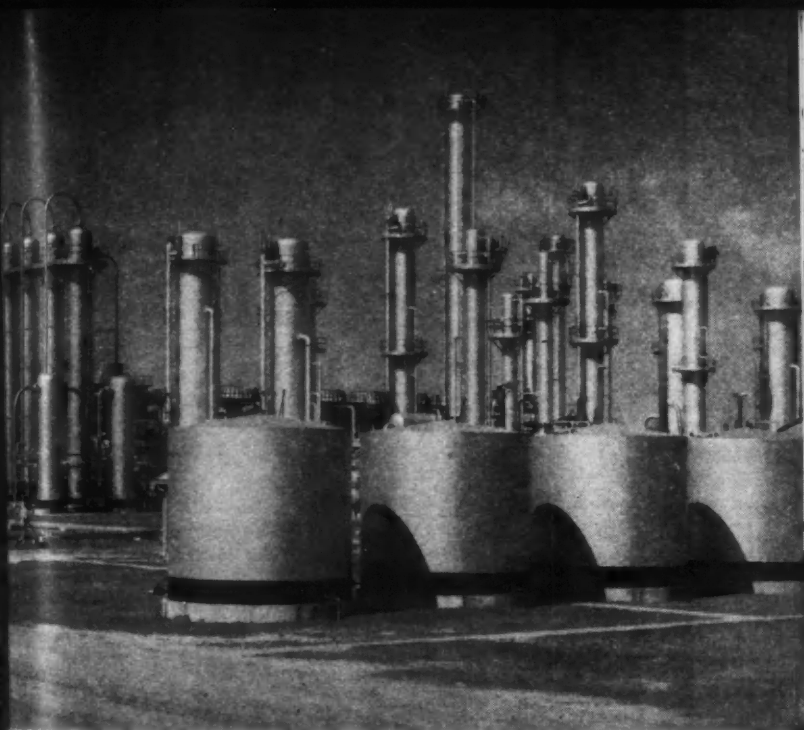
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—Photo courtesy Humble Oil Co., Houston, Texas

► IN THESE TOWERS, liquid constituents are removed from natural gas, under high pressure.

## Gas From the Earth

by WATSON DAVIS

► LUSH ENERGY rushes from the depths of the earth, and only about half of it, weight for weight and B.T.U for B.T.U., is what you would recognize as crude, smelly oil.

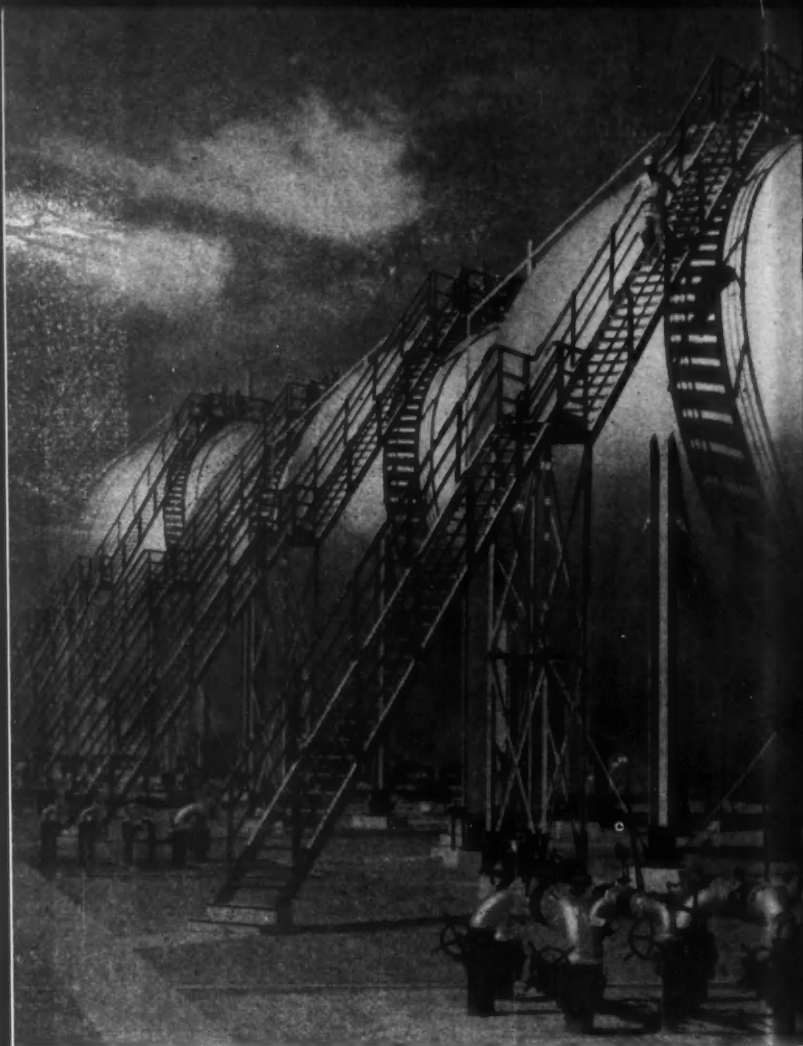
It is just a significant fact that stored in the sands a mile or two or three beneath the surface of Texas, Cali-

fornia, Louisiana and a few other fortunate places on the face of the globe, there is as much natural gas as liquid petroleum.

Gas that is in itself rich in energy, rich in chemical value, is bottled in the interstices of the ground under convenient pressure. Methane, ethane, propane, isobutane, normal butane,

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NOVEMBER 1946



—Photo courtesy Humble Oil Co., Houston.

➤ *GAS STORAGE containers are spherical to withstand a maximum amount of pressure with a minimum amount of steel.*



gasoline (even 72 octane ready to use in your auto), and heavy naphtha can be extracted from natural gas as it comes from a great gas field. And there is left the bulk of the gas, largely methane, to be piped to near or distant cities or industries to be used as fuel or chemical raw material.

The oil rush is still on. And the gas rush is hardly begun, despite the nearly 220,000 miles of natural gas pipelines that now connect gas fields with consuming centers, and distribute gas through cities.

A gas burner in a kitchen in Ohio is likely to be fed in part by natural gas that few days earlier was still underground in Texas. And a tankful of gasoline that is bought at a filling station in New York may never have had crude oil as its parent; for it could be largely liquid fuel from "wet" gas, extracted near a Texas gas well, and pumped to tanker side and shipped by water to the east coast.

Natural gas is now bidding for equality with oil, especially in Texas where petroleum is king.

► *MEN MUST PACK seismographic equipment on their backs to get through swamp land like this near the mouth of the Mississippi River in search of oil.*

—Photo courtesy Humble Oil Co., Houston, Texas



The flaring torch of gas that burned day and night near an oil well once was the blazing symbol of petroleum production. When the gas can not be used, these flares are a necessary means of disposing of waste gas that is produced along with the oil. If it were not ignited and burned as produced, it might mix with air and provide dangerous explosive mixtures to be touched off by a smoker's match or a spark of static electricity.

Today the oil men are a bit sensitive and defensive about the gas flares that advertise as brilliantly as a neon sign that gas is being wasted. Whenever economically possible the gas produced along with oil is passed into a collecting network of gas lines and taken off to feed a natural gas pipeline. Soon the airplane traveler by night will not be able to tell when he is passing over an oil field by observing torches of gas dotting the landscape below.

To oil production, gas is more valuable for its underground pressure and its part in forcing oil to the surface than it is for itself. The trick in managing an oil well or an oil field is to produce as little gas as possible and use the gas underground to force the oil to the surface to the greatest extent possible. All the skill of drilling and logging the wells and the scientific judgment of the geologists are used to tap the oil sands where the oil will have the helping pressure of the associated gas and salt water.

Although there is always some gas associated with oil, there are vast natural gas fields in which there is no oil. In early days of the oil business, such fields were treated a bit like

step-children, but today they are valuable properties, second only to the oil fields themselves. An increasing percentage of natural gas production comes from gas wells as distinct from oil wells, and now two-thirds of the gas that goes into the pipe lines is from gas fields.

Gas is a far cheaper fuel at the well than oil. About 6000 cubic feet of natural gas is the equivalent of a barrel of oil. Gas can be bought for 4 cents or less a thousand cubic feet, or not more than a quarter of a dollar for the equivalent of a barrel of crude oil which sells in the neighborhood of \$1.35. Thus gas is worth about a sixth as much as oil in dollars and cents.

Getting gas to the users is more difficult. It must be piped all the way. It cannot be taken down to the sea in ships. And pipeline transportation is more expensive than tanker haulage. The Big and Little Inch pipelines, built during the war at a cost of \$140,000,000 to take oil to the Eastern seaboard when sea routes were haunted by U-boat wolfpacks, are now surplus because it is cheaper and more convenient to revert to the use of tankers in time of peace. To move 6,000 cubic feet of gas from Houston to New York by pipeline costs five times as much as shipping the equivalent barrel of crude oil by tanker.

Nevertheless, the Big Inch, two feet in diameter, might be used to convey natural gas from Eastern Texas to the New York area with considerable industrial consequences, including lessening the demand for coal, a prospect distasteful to John L. Lewis and his United Mine Workers.

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—Photo courtesy Humble Oil Co., Houston, Te

► *OIL BEARING STRATA are found beneath the bottom of the Gulf of Mexico, so geologists go out in boats to search for it.*

Just as crude oil is not utilized exclusively (or even usually) in the form that it comes from the ground, so natural gas seems likely to be viewed in the future as a raw material rather than a finished product. Gasoline, a host of petroleum products and an array of chemicals will be manufactured from it. The process for the synthesis of gasoline and other products from natural gas is very parallel to the way in which the Germans,

under stress of their lack of petroleum, made liquid fuel and chemicals from coal.

Conversion of natural gas into gasoline is now considered to be not only technically possible but competitive with production of gasoline from petroleum. The rising cost of crude oil combined with the development of technological processes have made practical the synthesis of motor fuel from natural gas. Oil prices need only

rise somewhat higher in the future to make it feasible from a dollars and cents standpoint to make gasoline from the gas from coal.

The plant for making gasoline from natural gas that is nearest completion is one that is being built at Brownsville, Texas, by Hydrocarbon Research, Inc., financed by several oil and natural gas companies and the government.

The basic process in making synthetic gasoline from natural gas is the Fischer-Tropsch synthesis, originally developed in Germany not long after the first World War to make gasoline from coal. Carbon monoxide and hydrogen in this process are synthesized into gasoline catalytically. This gas to be used in the synthesis, in one process to be used commercially, is made from natural gas by partially burning the methane of natural gas with large amounts of oxygen. In the Brownsville plant under construction, the world's largest oxygen plant, producing 20,000,000 cubic feet daily, is required.

In American versions of the synthetic process, fluidized catalysts, instead of pelleted or granular catalysts, are used. The material that promotes the chemical reactions is handled in finely divided form in such a way that it is maintained in a fluid condition in all parts of the operation and flows like water. Such fluid catalysts have been used in catalytic cracking of oil which has been a major factor in improving the quality of motor gasoline and in producing during the war the raw materials for 100 octane gasoline and synthetic rubber.

Fluid catalysts move along with the materials being acted upon and thus they carry with them to the places where it is wanted the heat that is generated in the reaction. The older solid forms of catalysts had to have heat removed from them and various sorts of reactors were used. The capacity of the equipment was limited to its ability to remove heat. In an analysis of the possibilities made by the Standard Oil Development Company, the Standard Oil Company (New Jersey) research organization, it was found that for a plant to produce 10,000 barrels per day of synthetic hydrocarbons, using the German design, 128 reactors with 5,800,000 square feet of cooling surface would be required, while by use of fluid catalysts, it would be possible to reduce the reactors to four with a cooling surface of 250,000 square feet.

The cost of producing gasoline from natural gas by such a modified Fischer-Tropsch process may even be slightly lower than the cost of production of gasoline from crude oil, operationally, although a substantially higher investment is needed in the production from natural gas.

With such prospects and with natural gas as large a natural resource as oil itself (natural gas reserves are estimated at from 113 to 200 trillion cubic feet), it is little wonder that there is growing interest in natural gas as a raw material.

At least one other full scale plant, besides the Brownsville project, is building and this is a Standard Oil of Indiana project in the Houghton field in Kansas. Pilot plants are known to be being built by Phillips, Shell and

The Texas Company, while Standard of New Jersey has had a long program of reasearch in the field.

One of the oldest uses for natural gas is the production of carbon black, soot produced by its incomplete combustion. This material is so essential an ingredient of rubber as it is fabricated for tires and other uses that 90% of the carbon black produced is used in this way.

Natural gas is a raw material for many synthetic chemicals. Its methane molecule is a source of hydrogen for combination with nitrogen to make synthetic ammonia for fertilizer, explosives and other uses. Methane is used for making much of the synthetic wood alcohol or methanol, some of which is converted into formaldehyde. Chloroform and carbon tetrachloride are other methane derivatives. And natural gas can be used, when the need arises, in the manufacture of synthetic gases from which can be made other synthetic alcohols, acetone and other chemicals, now produced from

by-products from the cracking of crude oil to produce gasoline.

In some natural gas, there is helium, the inert, noninflammable element that, being a seventh the weight of air, is useful in inflating airships, blimps and balloons.

The non-fuel uses of natural gas, important as they promise to become, account for only 1.3% of the marketed production. Most of the gas, made within the earth millenia ago, is now being used as fuel. In a year there comes to market more than three and three-quarter trillion cubic feet of natural gas. That is a weight of about 91,000,000 tons, we are told, or about the weight of the steel industry's annual production. Its heating value is that of 150,000,000 tons of coal. And, if you are one of those who like to visualize statistics by such devices as draping freight trains around the earth, the natural gas used in a year would fill a great cubical trough three miles on each side.

## *Triptane Number for Gasoline*

► A NEW SYSTEM of rating motor fuels may result from the high quality gasoline developed for modern airplanes. A "triptane number", rating the fuels according to a leaded triptane-heptane scale, has been proposed at the National Bureau of Standards to replace the current octane classifications.

The trouble with the 20-year-old octane scale, according to the Bureau's Cooperative Fuel Research Committee, is that modern aviation fuels have gone over the top of the octane ratings. First prepared in 1926 to cover

higher knock rating fuels than any then used, the old scale is now out-of-date.

The newly-proposed rating would be in terms of blends of triptane and normal heptane, to both of which has been added about one-tenth of 1% of tetraethyl lead. Triptane is a relatively new compound of exceptionally high knock rating, and the new scale would cover a range from below to above present fuels.

So, one of these days, your gas may be rated with "triptane number."

## How Petroleum Geologists Locate Oil and Gas Wells

# Looking For Oil

by MORGAN J. DAVIS

Chief Geologist, Exploration Department, Humble Oil & Refining Company,  
Houston, Texas

➤ MUCH OF the crust of the earth is composed of sedimentary rocks as opposed to igneous rocks, i.e., rocks once molten, and as opposed to metamorphic rocks which were altered by heat and pressure from their original structure and composition. Sedimentary rocks, or rocks which were laid down under seas or lakes or by winds or by rivers, make up the far greater part of the rocks exposed on the surface of the globe and constitute an overwhelming percentage of the surface rocks in the state of Texas. These strata have been laid down from the earliest periods of the earth's history to the present time and are still being deposited in many areas, such as the Gulf of Mexico. The age of some of these sedimentary rocks may be measured in hundreds of millions of years. That portion of the earth's crust composed of sedimentary rocks is stratified much like a layer cake, and some of these strata retain their identities over great distances and over great areas or, in other words, they have lateral continuity while other strata or beds are lenticular and pinch out entirely in passing from one point to another.

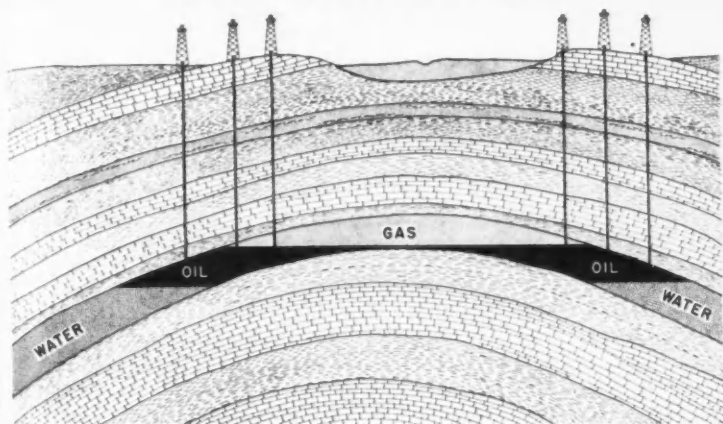
These sedimentary rocks, sometimes laid down under marine conditions in the sea and sometimes laid down in lakes or in deltas of rivers, often contain a great deal of organic matter,

plant and animal debris. Nearly all geologists believe that the origin of our petroleum oil and gas is from this organic material which was embedded in the strata at the time they were laid down or, stated otherwise, that oil and gas come either from plant or animal material or from a combination of both. It is presumed that this organic material, after burial, has been transformed by heat and pressure in Nature's laboratory into those hydrocarbons we know as oil and gas.

Geological studies, particularly during the past 20 years, have led more and more to the conclusion that most of the oil fields of the world are found in sedimentary basins. These are areas where the crustal rocks have subsided or have been downwarped over long periods of geological time, with the result that great thicknesses of sediments such as shales, sands, limestones, clays and conglomerates have been laid down in them. Geologists sometimes refer to these basin areas as geosynclinal areas.

One of the most important prerequisites of a potential oil-producing area is the presence of reservoir rocks in the subsurface, i.e., rocks which are porous and have sufficient voids in them to contain oil and gas in sizable quantities. One cannot ordinarily hope

## DOMAL TYPE OF OIL TRAP



to produce commercial quantities of petroleum from impermeable rocks such as shales or dense limestones even though they are saturated with oil since the absence of permeability would prevent the oil from flowing from them.

The presence or absence of possible reservoir rocks such as sand and cavernous or porous limestones can sometimes be predetermined by a study of the outcrops at the edge of the basin, where one may examine, on the surface, rocks which are deep in the subsurface farther toward the center of the basin. Random exploratory wells or stratigraphic tests (core-drilling), drilled for geological information only, may furnish clues as to the possible reservoir rocks where surface studies will not suffice.

As already stated the amount of organic remains present in any sequence of rocks under study is of much inter-

est to the geologist, since this is believed to be the source material of petroleum. Thick sections of carbonaceous rocks are preferred rather than thinner measures but particularly is organic debris regarded as important in beds proximate to the possible reservoir strata.

Another point about which the geologist is concerned is the question of whether there is a caprock or "seal" at the top of the porous medium in which he hopes to find a petroleum accumulation. This feature is necessary to prevent the upward migration and loss of oil or gas which might otherwise accumulate in the reservoir rock. Experience has shown that a considerable thickness of relatively impermeable beds, sometimes referred to as "cover", above a possible reservoir rock is usually necessary to retain oil and gas accumulations. This thickness is variable, ranging from several



hundred feet to several thousand feet, depending on the local geological conditions present.

Thus, in selecting places where oil may occur, the geologist first prefers those within sedimentary basins, next examines the geologic section or sequence of rocks to see if they are thick enough and if possible reservoirs with caprock and nearby source material are present; but there is another vital factor he must establish before he can hope for a discovery. Fortunately, the occurrence of hydrocarbons in sedimentary rocks is widespread but there must be folding, faulting or interruptions of porosity in these beds before oil and gas will accumulate in sufficient quantities to justify drilling wells and producing the hydrocarbon fluids from the porous rocks which contain them. In other words he must establish the presence of structures or traps in which conditions are favorable for the accumulation of oil and gas in commercial quantities. All traps containing petroleum accumulations are directly or indirectly the result of deformation of the earth's crust, i.e., folding or faulting or uplifting of the sedimentary rocks.

After the geologist has found a structure and is satisfied as to all the necessary conditions that I have attempted to outline and has considered scores of minor factors it is not necessary to mention here, the area is leased, a location staked and a drilling rig moved in for a wildcat or exploratory test. If the proper combination of geological factors has been correctly interpreted, if mechanical difficulties do not prove insurmountable, and if

a sufficient depth to test prospective producing horizons is reached, a discovery of oil is likely to result.

After the discovery of a new field, the geologist is still not finished with his task and the petroleum engineer is only at the start of his. Together the geologist and engineers initiate a careful study of the physical characteristics of the producing reservoir which constitutes the new found field. Cores and samples of the reservoir rock or "sand" are analyzed to determine the porosity, permeability, content of connate water, grain size and shape, and all other properties which might have a bearing on the flow of the hydrocarbon fluids through the reservoir. Detailed subsurface maps are constructed and constantly revised. Gas-oil and oil-water contact are carefully determined and completion techniques are planned accordingly. Studies of proper well spacing are made both in the field and in the laboratory. Well pressures are a matter of constant concern and rates of flow are related to them.

Before the oil industry directed its technical men to the study of oil and gas reservoirs, enormous flush production in new fields, great wastage of gas followed by sudden pressure drops, production of water which by-passed oil, and early placing of wells on the pump were all regarded as inevitable events in the life of a producing field. Little thought was given to the question of whether or not these practices affected the ultimate amount of petroleum which should be produced in any given field.

As studies of oil and gas reservoirs progressed, supplemented



by laboratory data and contributed to by controlled experiments under actual producing conditions, it became apparent to all petroleum engineers and production geologists that the scientific exploitation of oil fields is only slightly less important than the discovery of the fields in the first place. They were forced to these conclusions because, as a result of their studies, it was found that many fields had been produced at rates so excessive that reservoir pressures had been dissipated, water had been drawn in prematurely and, through the lowering of the pressure, the viscosity of the oil had been increased, causing a large amount of it

to remain the sands after the untimely death of the field. They also found that in many of the older fields a much smaller number of wells would have served to produce the same, or a larger, amount of oil and gas and that great numbers of unnecessary wells had resulted in economic waste. They found that fields are not alike, that the mechanism of the reservoirs differs greatly, but that in all types of fields production beyond the maximum efficient rate for each type of reservoir will result in underground waste of oil which can never be recovered by ordinary methods of production.

### *On the Back Cover*

► PROVING that chemicals can be used for other things than explosions, this model farm is maintained near Modesto, California, by the Shell Oil Company to test oil chemicals which can aid agriculture.

In reviewing some of the problems which challenge the researcher, Dr. Roy Hansberry, the laboratory's director and formerly associate professor in Cornell University's entomology department, listed the corn earworm, the codling moth in apples and pears, the sugar beet nematode, which has been known to destroy entire crops in certain areas, and the mites found on many other crops. He also mentioned the problems of toxic soil conditions,

and a host of plant ills, including blights, wilts, rots, smuts, rusts, cankers and molds.

The laboratory is also engaged in developing such products as sprays which will kill weeds without damage to crops, and plant growth regulators to provide earlier crops and to regulate the size and uniform ripening of crops. In addition, it is developing ways to delay fruit trees from blossoming through the dangerous frost period.

The new research center is a coordinated activity of Shell Oil Company, Shell Chemical Corporation, and Shell Development Company.

Known oil reserves in the world are estimated at 20,000,000,000 barrels which can be produced by present methods of recovery at present prices; by more costly methods much more could be produced.

## Petroleum Chemicals Aid the Farmer

➤ NUTRIENT SOLUTIONS are pumped through the irrigation system of this model farm, shown in airplane view on the back cover. In three large greenhouses at the Modesto farm laboratory, specialists inject new oil derivatives into soil infested with destructive agricultural pests, and check plant growth for results. In the outside fields, orchards and gardens, crops are treated with the greatest possible variety of oil sprays and chemicals, in the search for materials and methods which will nourish plants, kill their parasites, control their diseases, regulate their reproductive processes and delay their old age.

—Photo courtesy Shell Oil Co., Modesto, Ca



## Better Gasolines Result From Rearranged Molecules

# Gasoline Tailored To Fit

► OIL CHEMISTS have as their chief problem the production of gasoline with 100 octane rating out of whatever kind of liquid hydrocarbons come out of oil wells. As requirements of users have progressed from meeting simple fuel needs to supplying aviation grade gasoline to power high-compression engines run under difficult conditions, the chemist's ingenuity has been taxed to find or create the particular hydrocarbon compounds which have the properties desired.

Several sessions of the recent American Chemical Society meeting at Chicago were the gathering place for those who are working in this field. They attacked the problem on many sides. Some of their reports, of general interest on account of the principles used, are brought together here to give a picture of modern oil refining.

► AIR OPERATIONS carried on by the United States and its allies during the war depended upon adequate supplies of 100 octane aviation gasoline. This 100 octane aviation gasoline consists of mixtures of very high octane blending agents and high grade base stocks, manufactured principally by cracking catalytically the naphthas and gas oil stocks derived from crude petroleum. The final aviation blend was required to have high octane number both by lean mixture and rich mixture rating. That is, the aviation fuel must permit high aircraft engine performance both under conditions of

normal flight and the extreme conditions prevailing during take-off and combat.

The suitability of catalytically cracked base stocks for inclusion in aviation fuels is judged principally by their octane number characteristics and degree of unsaturation. The term "unsaturation" is a measure of the olefin content of the gasoline. Olefins are a class of reactive hydrocarbons which, if present in substantial quantities in gasoline, result in gum deposition and poor susceptibility to the effect of lead in raising octane rating. Low olefine content is favorable for lean mixture octane ratings while a high content of aromatic hydrocarbons is favorable for rich mixture octane ratings.

During the war it was found desirable to operate fluid catalytic units producing base stocks at high temperatures, thus increasing plant capacity because of higher conversion, and raising the yield of butenes which were in extreme demand for the manufacture of "alkylate," another high octane constituent of aviation gasoline.

These high temperatures produced gasolines with high aromatic contents favorable for rich mixture octane ratings, but the gasolines were high in olefins which made them undesirable from the standpoint of lean mixture octane ratings.

In view of the overall desirability of high temperature cracking, the evi-

dent problem was one of finding the best method for improving lean mixture octane rating of the aviation base stock without detriment to rich mixture performance. Retreating catalytic gasoline by a second pass over the cracking catalyst was one answer to this problem but a loss of valuable product was incurred. As an alternate it appeared that hydrogenation of the catalytically cracked gasoline might be a desirable process if conditions were used to affect only the olefins and not the aromatics. Hydrogenation of olefins converts them to higher octane number isoparaffins, but hydrogenation of aromatics converts them to naphthenes with attending loss in rich mixture octane rating.

Results of laboratory work done to discover the proper methods for selectively hydrogenating olefins in cracked gasolines were entirely successful, Alexis Voorhies, Jr. and W. M. Smith of Baton Rouge and C. E. Hemminger of Elizabeth, N. J., all chemists with the Standard Oil Co., reported at Chicago. Catalysts were developed which permit the required selective action at pressures ranging between 150 pounds per square inch and 3,000 pounds per square inch. This hydrogenation process was applied on a large scale in the high pressure plant of the Standard Oil Company of New Jersey at Baton Rouge, Louisiana and in the low pressure plant operated for the Defense Plants Corporation by the Humble Oil and Refining Company at Baytown, Texas.

If lack of hydrogenation capacity limits production of aviation gasoline, it may be advantageous to by-pass part of the catalytically-cracked base

around the hydrogenation unit. By distilling the catalytic base into a light pentane cut, a heart naphtha cut, and a high boiling cut and hydrogenating the heart cut alone, a more efficient utilization of given hydrogenation facilities is attained with no loss in quality of finished base. The light pentane cut was found to have no better lean mixture octane number after hydrogenation than before. More advantageously this light material contains unsaturates which, like the butenes mentioned before, may be converted to valuable alkylate by another process. The by-passed high boiling cut itself contains few olefins, but is rich in aromatics, and may be put back into the finished aviation base after a light treatment with acid to reduce its gum forming tendencies.

In keeping with the wartime desire to increase aviation gasoline production it is claimed the hydrogenation process offers a distinct advantage over catalytic retreating in reducing olefin content. In catalytic retreating the reduced olefin content is realized principally by olefin removal with loss in yield, often as much as 25 per cent. On the other hand hydrogenation converts the olefinic molecules to isoparaffins by simple addition of hydrogen. Accordingly, product yields from the hydrogenation process are virtually 100 per cent. In commercial installations this process has contributed extensively to the production of 100 octane number aviation gasoline by producing in high yield a base stock of improved quality and higher lean mixture octane number without any sacrifice in rich mixture performance.

## Mechanism of Cat Cracking

► **CRACKING** is a term applied to the breaking down of a large molecule of petroleum into two or more smaller molecules. A major part of crude petroleum is composed of molecules too large to be used as gasoline. Everyone knows that motor oil cannot be used to run an automobile and even kerosene makes a very poor motor fuel, because these materials boil too high, that is, their molecules are too large. But these molecules can be split or cracked to smaller molecules, which do boil in the right range, by the application of high temperatures around 1000° Fahrenheit.

Thermal cracking depends on heat alone to break down large petroleum molecules, but the octane number of thermal gasoline is not high enough because of the structure of the smaller molecules. This is to say that the way in which heat alone breaks down petroleum does not produce the best kind of gasoline.

The chemist uses catalysts to help him control the way in which a molecule reacts. These catalysts are not used up in the reaction but may be used over and over again until they become changed due to heat or some by product which poisons them. Cracking catalysts may be used for as long as two years before heat and impurities in crude petroleum make them inactive.

Catalysts control the way in which a molecule reacts by speeding up the reaction. If a molecule can behave in several different ways, which is almost always the case, the catalyst may speed up one of these reactions to

such an extent that all other possible products may become insignificant. Different types of catalysts may affect different possible combinations, so that by choosing the proper catalyst the chemist can get the product he wants.

The cracking of petroleum by heat alone does not produce the types of molecules which possess the highest "anti-knock" properties. The rate at which other hydrocarbons are formed from larger molecules is much faster, in the absence of a suitable catalyst, than that which produces molecules of the anti-knock structure. Certain catalysts speed up the rate of the preferred reactions to such an extent that the gasoline produced contains large amounts of high-octane rating molecules.

The mechanism by which some types of catalysts work is fairly well understood by chemists. In many cases the molecule undergoing reaction combines with the catalyst to form what is called an "intermediate compound or complex." This intermediate complex can react much more readily than the original molecule, and hence the net reaction rate of the original molecule may become very fast, if the complex is formed rapidly and subsequently breaks up to give the reaction product and regenerate the catalyst.

The mechanism by which cracking catalysts function is undoubtedly the least understood of all important catalytic reactions. Commercial cracking catalysts are of two general types, although these are very similar in

their action. The catalyst first used successfully is a special type of natural clay which has been "activated" by leaching with acids. Later, improved catalysts were developed by synthetic methods. These consist of silica in combination with other metal oxides such as alumina, zirconia, and magnesia. It has been difficult for the chemist to explain the action of such catalysts on the basis of intermediate complexes, because silica (such as ordinary sand) and the other oxides which are necessary to the catalyst are not known to react directly with hydrocarbons (petroleum).

The research work reported by R. C. Hansford of the Socony-Vacuum Laboratories, Paulsboro, N. J., has shown that one important component of cracking catalysts has been overlooked, namely, water. All active cracking catalysts contain a small amount of water, and if this water is removed the catalyst ceases to function. By replacing the ordinary water in cracking catalysts with "heavy water" it has been shown that the atoms of "heavy hydrogen" in the

heavy water exchange with the atoms of "light hydrogen" in the petroleum molecules.

This proves that water combined with the catalyst is the link between catalyst and hydrocarbon during the cracking process, making possible an explanation based on the formation of an intermediate complex. It is now believed that the chemical nature of cracking catalyst surface is very similar to that of a fairly strong acid, water being the source of hydrogen ions. These ions may react with a petroleum molecule to form an intermediate complex, or hydrogen can be taken from a petroleum molecule in the form of a hydrogen ion, creating an intermediate complex from the original molecule. These intermediate complexes are less stable than the molecules from which they are formed, and can decompose to smaller molecules. The compounds made up of these smaller molecules have a different structure from that found for the compounds produced directly from the large petroleum molecules by thermal cracking.

## Products of Cracking

➤ BECAUSE PETROLEUM products are a complicated mixture of chemical compounds they do not lend themselves readily to analysis. The first step in such an analysis is a distillation of the total product which will divide the material into fractions according to their boiling point. Boiling point is approximately proportional to molecular weight and by distillation a mixture of hydrocarbons can be divided to give fractions which con-

tain all compounds of a given number of carbon atoms.

Having segregated the hydrocarbon fractions by approximate molecular weight, it is necessary to segregate them further according to molecular structure. The hydrocarbons are divided broadly into straight chain compounds and ring chain compounds. The straight chains are further classified as paraffins or olefins. The latter are unsaturated containing

less hydrogen than required to saturate all the carbon present. Similarly, the ring compounds are classified as naphthene or aromatic. The aromatics contain less hydrogen.

A method for the determination of the percentage of paraffin, olefin, naphthene, and aromatic compounds in the hydrocarbon fractions has been developed by intensive hydrocarbon research in a number of laboratories. The results of these studies were reported to the American Chemical Society by C. E. Starr, Jr., J. A. Tilton, and W. G. Hockberger of Esso Laboratories, Standard Oil Company of New Jersey, Louisiana Division, Baton Rouge.

Catalytic cracking produces a synthetic crude from an intermediate crude fraction. The feed contains no gasoline or lighter material and the synthetic crude contains a full range of compounds from hydrogen and methane and other gases to materials of fuel oil boiling range. In this work, the cracked products have been analyzed over the range from the butane gases of four carbon atoms to fractions containing about eight car-

bon atoms which boil at approximately 350°F. These are the compounds which are included in a full range gasoline.

The composition of the cracked products is found to vary regularly with the severity of cracking. The greater the severity, the greater the concentration of aromatics in the cracked products. The gasolines or naphthas from naphthenic-type feed stocks are characterized by high yields on feed together with high aromatic concentrations, reflecting higher yields of toluene and aromatics of eight carbon atoms (i. e., six carbon ring plus side chains). The production of benzene is very low, averaging less than one-half per cent of the feed. At conditions of constant severity of cracking, the total production of olefins increases with higher molecular weight or boiling range feed stocks.

Highly aromatic fractions are not only highly valuable as solvents and petro-chemical raw materials, but also the gasoline octanes are enhanced by the presence of high aromatic concentrations. High boiling range olefins are detrimental to octane number.

## Catalytic Salt Systems

► CRACKING by catalytic action has become more and more important during the years that gasoline requirements have become more stringent. As carried out on a commercial scale, it is essential that the fluid hydrocarbons pass continuously over or through the catalytic material to come into immediate contact with it. Maintaining the proper temperatures at the different parts of the plant is one of the important parts of the design

of such continuous flow operations. The Houdry Corporation has been successful in the design and operation of one type of catalytic refining process. Details of phase relationships in the chemicals used as catalysts in their method were explained to petroleum chemists at the Chicago meeting of the American Chemical Society.

One of the major engineering design problems connected with the



Houdry fixed-bed catalytic cracking process, the solution of which contributed measurably to the success of the process, involved the need for a fluid which could be pumped through the intricacies of a catalytic converter and add a substantial amount of heat to the molecules as required during the cracking period (the period during which larger molecules are broken down into smaller ones along with molecular regrouping to form more desirable molecules) as well as remove a greater amount of heat from the catalyst during the regeneration period (the period during which air burns from the catalyst carbon which forms during the cracking period.)

The excess heat absorbed by the fluid could then be proportioned as required as preheat for the charge oil feed and regeneration air and as heat for producing necessary steam for the operation of the plant as a whole. The problem was further complicated by the requirements that the desired fluid be chemically stable at high temperatures in the normal operating temperature range of 800°F.-900°F., that it possess a high heat capacity (the ability of a given weight of a substance to gain or lose a large amount of heat during a slight temperature change), that it possess a low melting point (a desirable property since process steam can maintain the mixture as liquid in storage tanks), that it be relatively non-corrosive to ordinary carbon steel equipment and finally that the fluid be inexpensive.

The use of mixtures of nitrates and nitrites of sodium and potassium for heat transfer purposes has been known for some time, but it was not until the

period between 1938-1939 that full commercial use was made of any of the minimum freezing point mixtures of the four ions (nitrate, nitrite, sodium, potassium). By 1939-1940, at least 10 Houdry units were in operation, in which a commercial heat transfer salt containing 40% sodium nitrite, 7% sodium nitrate and 53% potassium nitrate, manufactured by the E. I. duPont de Nemours Company, was used. It later became apparent that an even more profitable mixture of these compounds could be employed, says J. Alexander, Jr. and S. G. Hindin, Houdry Process Corporation of Pennsylvania, Marcus Hook, Pa.

This latter mixture, containing 45% sodium nitrite and 53% potassium nitrate, was established after a careful examination of the basic salt system covering all mixtures of the four aforementioned ions. This eutectic mixture was chosen for use in all Houdry salt systems since 1941 because of its simple composition coupled with its unusually low melting point (285°F.).

Despite the fact that this mixture possesses in large measure the properties desired for use in the Houdry process and that the Houdry salt systems have been designed to prevent, within practical limits, contact between air or other gases and the molten salt, under normal operating conditions certain chemical reactions normally take place. These reactions are slow, and if allowed to continue, ultimately affect the utility of these systems by raising the freezing points beyond practical limits, or by forming insoluble materials which settle out in the systems.



The oxidation of the nitrite to nitrate by reaction with oxygen causes an increase in freezing point. The conversion of nitrite by reaction with water vapor to hydroxide (abasic ion), nitrate and nitrous oxide (a gas) causes first a decrease in freezing point to a minimum and then an increase to a point above that for the original salt mixture. At this point the hydroxide settles out as a glassy precipitate. Carbon dioxide reacts with the hydroxide forming carbonates which do not affect the freezing point until a sufficient concentration is reached beyond which they settle out as a white solid precipitate at temperatures above the original freezing point.

Commercial control of these chemical reactions as well as reconditioning of the salts has proven to be comparatively simple. The nitrate can be converted to nitrite by reaction with hydrogen gas. The nitrite concentration can be increased by discarding a portion of the mixture and replacing it with a 50.5% potassium nitrite—49.5% sodium nitrite mixture. The carbonate and hydroxide can be converted to nitrate by reaction with nitric acid. Carbonate may also be removed by cooling a side stream and allowing the precipitated carbonate to settle out in a suitable tank.

## Pure Hydrocarbon Research

► THE AMERICAN petroleum industry during the past war supplied aviators with the best fuel available to any airmen in the world. This is not just an accident. It was possible because the American petroleum industry has been progressive and had taken many steps long in advance of actual need to make sure it would have the necessary fundamental information concerning petroleum and products made from it.

One such step was the formation eight years ago of a project at Ohio State University under the direction of Cecil E. Boord for the synthesis of pure hydrocarbons in sufficient quantity so that they could be systematically tested for their performance in internal combustion engines.

The knowledge of combustion characteristics of the pure compounds

which were synthesized and tested in America made it possible for the American petroleum industry to pack into every gallon of aviation fuel the maximum of punch—punch needed for fast take off and quick climb, and the staying qualities needed for maximum cruising range.

During the war several other laboratories assisted in this general line of work, but the background in regard to this type of information has already been thoroughly laid, thanks to the program at Ohio State under Prof. Boord, which is now known as American Petroleum Institute Project No. 45.

At the September meeting of the American Chemical Society in Chicago, Prof. Boord presented before the Division of Petroleum Chemistry, in collaboration with 21 of his asso-

ciates, a report covering a portion of this work entitled "The Use of the Grignard Reaction in the Synthesis of Hydrocarbons." He stated that up to the present 153 hydrocarbons have been prepared in sufficient quantities for testing, and that, of these, 61 were prepared by the so-called Grignard reaction. This particular report from Prof. Boord's laboratory was concerned with the modern use of this old reaction in their synthetic work. Although this reaction has been known since 1900, it is still not completely understood. Its many and varied uses constitute a major chapter, and one of the most fascinating chapters, in the whole of organic chemistry.

Working with this reagent involves a definite degree of hazard since the solvents which are necessary are particularly inflammable, and it is also necessary to use chips or ribbons of metallic magnesium—the same metal used in old fashioned photographer's flash powder and certain types of bombs. The work therefore involves definite fire hazard, particularly when handling large quantities as was the case of Prof. Boord's program. The general type of procedure used by Prof. Boord in preparing hydrocarbons which involved the use of the

Grignard reagent involved the following steps:

- (1) Preparation of a hydrocarbon containing one atom of chlorine or bromine.
- (2) Reacting this with metallic magnesium in the presence of ether to obtain the Grignard reagent.
- (3) Reacting the Grignard reagent with a suitable aldehyde or ketone to obtain the corresponding alcohol.
- (4) Treating the alcohol under proper conditions to remove a molecule of water and obtain an olefin.
- (5) Hydrogenation of the olefin to the corresponding hydrocarbon.

These organic chemists under the leadership of Prof. Boord were able to make these molecules behave and go together as desired so that the products needed were obtained. The availability of properly trained chemists paid off for Uncle Sam's fighting men! The account of the excellent work of Prof. Boord and his associates again emphasizes the importance both in peace time and in war time, of an adequate supply of properly trained chemists.

## Gallium Thermometers

➤ GALLIUM THERMOMETERS that give direct readings of temperatures up to 1,200 degrees Centigrade have been discovered in Germany by British scientific investigators. The gallium thermometers show temperatures which otherwise would have been measured by thermocouples, disappear-

ing filament pyrometers or other indirect means.

Gallium, generally found as an impurity in zinc blends, melts at 30 degrees Centigrade, but it is not very volatile in red heat.

A technical report on the thermometers is now available in America.

## Melt

► CRUCIBLES retain their shape, whether their contents have been weighed by the microgram or by the ton. The name comes from a medieval legend of an ever-burning lamp magically maintained before the cross of Christ, apparently from the same story cycle as the Holy Grail legends. It suggests how the apparatus for melting metals developed from the primitive oil-burning lamp, which had to be made of a refractory material.

LABORATORY apparatus often appears in manufacturing operations magnified to astonishing sizes.

THIS steel crucible is a 260-ton lead kettle, one of six made for the American Smelting & Refining Co. by the Blaw-Knox Co. of Pittsburgh, Pa.



## Chemical Things To Do

### Etch Metal With Flashlight Cell

by JOSEPH H. KRAUS

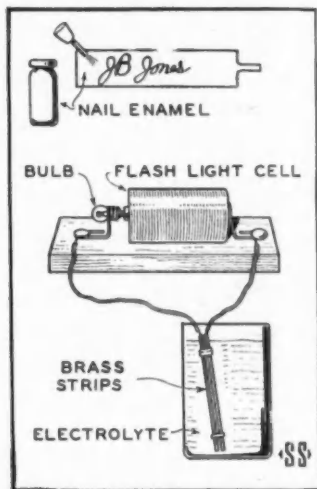
► MONOGRAMS, names or ornamental designs can be etched into metal plates by any junior scientist with the aid of a single flashlight cell. Etching, the reverse of electroplating, is done electrically—metal is removed from the plate instead of being deposited on it.

Best results will be obtained by using copper or brass plates. Cut two of them to the desired size. If possible, leave at the top of each plate a small tab or projection to which you can attach your wires. If your plate is too small for this, solder a small piece of copper wire to the back of each plate for the electrical connections. Polish one side of each plate until it shines brightly. Wash with soap and warm water to remove all traces of grease.

Handle by the tab only. Coat one of the plates with ordinary finger-nail lacquer, popularly called "polish." Any color or clear polish may be used. Make sure both surfaces and all edges of the plate to be etched are coated. Also cover the extending tab or the attached wire for a distance of a half inch. Otherwise the attachment may be etched entirely off and the connection broken before the plate itself is fully etched. No liquid nail polish is put on the second plate.

#### Scratch Design in Polish

After the coating is completely dry, lightly draw with a pencil initials, name or design on the polished surface. Following this penciled design, scratch all the polish completely off



with the point of a pen, a needle pushed into a pen holder, or some other sharp instrument such as a pen-knife or small screwdriver. If you make a mistake, daub over the area with the nail polish, let dry and begin scraping again. When you are finished, the polish should outline the design in the bare metal.

Now your plates are ready to be tied together. Remove the heads from three paper matches. Place one of them crosswise on top of the decorated plate and the other two lengthwise just below or alongside the design. Be sure the matches do not touch any of the tooled lines. Put the other plate on top so the matches keep them slightly apart, and snap two rubber:

bands around the plates to hold them in place.

### Connect With Battery

Now you want to connect your metal strips with the flashlight cell. First attach a piece of copper wire, such as doorbell wire, to each of the tabs.

The flashlight cell should be laid down on a small board. Two thumb tacks can serve as posts for the connection. You will want one at each end of the cell.

Wind the free end of each of your wires around one of the thumb tacks; also put one end of a paper clip under the thumb tack before you push it into the wood. The other end of one of the paper clips should be bent up so that it will make good contact with the bottom of the flashlight cell. This clip must be the one that contacts your wire leading to the plain plate that is not to be etched.

The free end of the other clip should be straightened, then bent around the threaded part of the base of a one-cell flashlight bulb. This should be bent over in such a way that the base of the bulb is held in contact with the center post at the top of the cell. Be sure that the wire leading from the bulb is connected to the plate to be etched.

### Test Circuit With Coin

To make sure you have a complete circuit, test by pressing a coin or the blade of a knife across the bare portion of the two tabs extending from

the metal strips. When the circuit is thus closed, the bulb should light brightly.

Make your own electrolyte by dissolving copper sulfate in water. Add as much copper sulfate as the water will dissolve. If copper sulfate is not available, however, you can obtain excellent results with ordinary table salt dissolved in water.

Immerse the two metal strips in the solution. The bulb, which acts as a limiting resistor to prevent a direct short of the cell, should glow dimly. If it glows brightly, the plates are probably touching and should be remounted to eliminate the short.

Let the metal strips stand in the solution for several hours or even overnight. The depth of the etching will depend on the length of time current is allowed to pass between the two plates. When you see bubbles forming on the design, you know that the plate is being etched.

### Etching Has Depth

A single new flashlight cell will easily etch a name plate to a depth of a sixteenth of an inch before it becomes exhausted. A new bulb, however, will not burn out and can be used again.

Remove both plates from the solution and use nail polish remover to take off the polish. Now you have a beautifully etched metal plate showing your initials, name or an artistic design in metal. Cut off the tab or remove the wire connection and the plate is ready for use.

Table vegetables may be either relatively high or low in phosphorus, calcium, nickel, cobalt, iron, copper, or other elements without any external indication in the appearance of the plant; the mineral content is governed by soil condition.

## Chem Quiz

### How Long Has This Been Going On?

► THE DATES BELOW give the ages of some chemical elements prominent in the news lately, and a few others for good measure. And just to make it easy, we give you the names of the elements, too, but we mixed the order a little. Can you match date and ele-

1735	Aluminum
1755	Bromine
1766	Cerium
1771	Chlorine
1774	Chromium
1789	Curium
1797	Fluorine
1803	Hafnium
1811	Helium
1823	Hydrogen

ment, and find out how long the world has known that each one exists? One date in the list is correct as it stands. If you just can't wait to find out, turn to the matched lists on page 56. But it is more fun to guess. Score 5 for each one correct.

1827	Iodine
1828	Magnesium
1828	Neon
1868	Platinum
1885	Plutonium
1898	Praseodymium
1898	Radium
1922	Silicon
1942	Thorium
1945	Uranium

### *Levulose Available for Experiments*

► A PILOT PLANT at Boulder, Colorado, is producing a sugar of high sweetness that won't help the rationing situation but may reveal secrets of the human body's processes. The sugar, levulose, or fructose or fruit sugar, will be available for the first time in sufficient quantities for experimental work by scientists, Dr. Carl W. Borgmann of the University of Colorado Engineering Experiment Station reported.

A simple natural sugar with potential uses in food industries, levulose is known to be important in the human body, starting in early life. Scientists have previously been handicapped by lack of this sugar in research experiments.

Levulose with radioactive carbon 14 may be used in future studies to follow the course of the sugar through the various body organs.

Operated on a grant from the Sugar Research Foundation, the pilot plant here uses an ion exchange process to obtain levulose from common sugar or beet molasses.

Dr. Borgmann said that studies are now being carried out at the Michael Reese Hospital, Chicago, to find out more about the storage of levulose in the body, its use by various organs and its effect on blood lactic acid, while Dr. I. M. Rabinowitch of the Montreal General Hospital is studying the rate of absorption of levulose in the body.



## No More "Mad Hatters"

► THE "MAD HATTER" has disappeared and there is no possibility of his reappearing in the United States, thanks to studies by industrial hygienists of the U. S. Public Health Service.

The hatter's proverbial madness, characterized by the "shakes" and mental disturbances, was due to mercury poisoning acquired on his job of hatmaking. John J. Bloomfield, assistant chief of the Industrial Hygiene Division of the federal health service, told how this hazard to workers' health was conquered, when he appeared as guest of Watson Davis on *Adventures in Science*, radio program presented under the auspices of Science Service over the Columbia Broadcasting System.

Mercury was formerly used as a carroting agent to increase the felting properties of rabbit and other skins used for felt hats, he explained. Hat makers displayed mental and physical symptoms in proportion to the amount of mercury vapor to which they were exposed in a later stage of hatmaking. The poisoning affected 8 percent of the fur cutters and 12½ percent of the hat makers.

Better ventilation and housekeeping in hat manufacturing plants were recommended and installed. Then, some years later, a representative of the hatting industry came to the U. S. Public Health Service with the announcement that he had found a substitute for mercury as a carroting

agent. As a result, industry, labor unions, the federal health service and the Commissioner of Health in Connecticut, which has a large number of fur cutting and hat manufacturing plants, got together and urged all states to forbid the use of the mercury carot in the fur cutting industry.

The job of protecting workers' health is a never-ending one, Mr. Bloomfield said. Every time a new product or device is introduced from plastics to television, every time a new industry is developed or a change is

made in an industrial process, a new hazard to workers' health may be involved.

Industrial hygienists have developed the technique and the "know-how" to solve practically any problem presented to them, Mr. Bloomfield said. These health workers wish they would be consulted when a change in industrial process or manufacture of a new product is in the planning stage, so they can advise how to avoid hazards to workers' health before the workers start on the job.

## *New Engine Has High Efficiency*

► A NEW ENGINE, developed by the Cooper-Bessemer Corporation, delivers more power for the amount of fuel consumed than any engine heretofore produced, it is claimed. It is a turbo-charged gas-diesel engine. Technically, it has high thermal efficiency, which is the engineering term for the amount of fuel consumption in relation to power developed.

Its thermal efficiency is rated as over 40%, which is a higher record than

ever obtained by a steam, gas, gasoline, gas turbine or diesel engine, the manufacturers state. The record was set during routine tests. The best record, heretofore, was established by the diesel engine, which operates usually between a range of 32% and 36%. The highest thermal efficiency claimed for a gas turbine engine is 29%; gas and gasoline engines usually attain up to 25%, and reciprocating steam engines from five to 18% thermal efficiency.

## *Under-Water Cutting With Hydrogen*

► A NEW METHOD of under-water cutting of steel plates on sunken vessels, using electricity and gas in combination, has been developed by Dr. K. Khrenov, of Moscow, who is responsible for many under-water cutting techniques that have been successfully used in the removal of collapsed bridges and ships from Russian river bottoms. In his method a stream of hydrogen is sent into the cutting elec-

tric arc, resulting in a considerable saving of electricity.

Dr. Khrenov suggested using electric-arc welding under water 13 years ago, when he found that the arc is protected by gas bubbles formed. The arc is protected in much the same way that the flame in a lamp is protected from air currents by the glass chimney. Arc welding and cutting under water are common practices throughout the world.



**College Training For Soldiers  
Set Up by U. S. Army in Europe**

## American Universities Overseas

by DR. WARD V. EVANS

*Upon the occasion of his being awarded the Honor Scroll of the American Institute of Chemists recently in Chicago, Dr. Evans gave the following account of his work in the Army's venture into higher education. In introducing the speaker at the testimonial dinner, his friend, Dr. Gustav Egloff of the Universal Oil Products Co., said of Dr. Ward:*

*"In 1945 he retired as Head of the*

*Chemistry Department at Northwestern, but 'retired' is a very poor word to use in describing his subsequent activities. He voluntarily left one of the world's finest and best equipped chemistry departments at Northwestern University to teach for the Army Universities in war scorched Europe. The problems abroad were a challenge which only a man who truly loved teaching would care to encounter."*

➤ AS YOU KNOW, veterans are guaranteed a certain amount of education by our government, provided they can qualify for it. When the war ended in Europe, the Army suddenly developed a plan for taking that education overseas to boys who had to remain there on occupational duties. So-called "command schools," on secondary school level, were set up in many areas, and two Army Universities, offering courses exactly as they would be given in this country were established—one in England and one in France. My particular duty was to set up and provide the teaching staff for the Chemistry Departments in these two universities, at Shrivenham and Biarritz.

In the spring of 1945 I spent a month collecting this staff—ten civilian teachers from American universities and eight drawn from the Army who are college teachers in civilian life. Intensive courses in 8-week per-

iods were offered and only the best qualified G.I. applicants were admitted as students. In all, 18,000 men enrolled; about 10% of these in Chemistry courses. As usual when the Army undertakes any new project, it spared no trouble or expense to equip and operate these schools. It was astounding to find laboratories and classrooms set up as fast as we ordered them. It was most heartening to have the response we had in personnel. All of us agreed we had never had such eager, serious students as those G.I.'s who knew by then what it was all about; and a finer, more co-operative teaching group was never assembled anywhere.

The universities were typical American universities, even to the Saturday afternoon football games last fall. Credit for the courses could be transferred to the colleges at home when boys returned, thus shortening the time on their education so many had to make up.

Our General Chemistry course carried a credit of 6 units, meeting 5 times weekly, with 6 hours of laboratory work, 2 hours of conference and 2 hours of quiz. The ground covered was approximately one semester of General Chemistry. At Shrivenham, England, we ran 4 sections of this course. Following it, students were ready to start the chemistry of the metals and Qualitative Analysis.

The Organic Chemistry consisted of two sections of 40 students each, with 4 lectures, 2 conferences and one 3-hour laboratory period each week. We covered the aliphatic compounds in this time.

The Physical Chemistry was a semester course, carrying 3 units of credit and meeting 5 times weekly. We offered no laboratory but *plenty* of problems.

In addition to these we had a course in Advanced Organic Chemistry, 5 hours a week, and at Biarritz a course in semi-micro Qualitative Analysis.

We had laboratory space for 160 students in General Chemistry and 60 in Organic. How a laboratory and a first class laboratory was made from a kitchen, as Berzelius or Scheele would have done, is a story in itself. How it was equipped by many "scrounging" expeditions by air, train, and truck to liberate apparatus and chemicals which originated in Italy, Germany, France and England is also a story that perhaps I should not dwell upon too extensively. Considerable quantities of this material were also collected from our own supply dumps in England. The actual construction and place for the laboratory was conceived

by our military personnel who saw to the building and equipping of desks and lockers, the storeroom and balance benches. Actual labor was done by German war prisoners, or P.W.'s. The supplies that were collected and catalogued, coupled with the ingenuity of the faculty and their skill as glass blowers, made an admirable laboratory. The storeroom was in charge of very capable P.W.'s, one of them a school teacher by profession. The laboratory floors and desk tops were cleaned daily by P.W.'s.

The Chemistry given at these American Universities compared favorably with any Chemistry given in the States, for three reasons: 1. The students were carefully chosen, serious men who desired an education. 2. We had a faculty of superior teachers very much interested in student problems, and capable of imparting chemical knowledge in the best possible way. The success of a project such as this depends upon men who can teach and love to teach; men willing to leave their jobs back home to bring their experience and knowledge to the soldiers. 3. The fact that our military personnel were there on the ground, able to organize our excellent laboratory, collect supplies, catalogue them and put the machinery into motion.

The students were drawn mostly from units not expected to be sent home within the school term. They were not problem children but real students. They were ready to work at their books just as hard as they fought in Germany. There were practically no absences either from class or laboratory. They were under a minimum of Army discipline and

finding their way back scholastically in a satisfactory manner. They even asked for "home work" when none was assigned.

Our classes ran from 8 to 12 and from 1 to 5 daily, except Saturday and Sunday. Student programs were so arranged that most of the work could be taken either in the morning or the afternoon, thus making half of each day available for extra-curricular activities—athletics, orchestra, glee club, drama, and educational trips to historic shrines. There was no military drill. The library was spacious and crowded with eager students all day and until late in the evening.

We had many visitors from English schools and a definite lecture program for both students and faculty was organized, bringing the best lecturers in England on special topics.

This American University was situated at Shrivenham in south central England about 75 miles from London and 23 miles from Oxford. The surrounding country is noted for its scenic beauty and its points of historic interest. Shrivenham itself is a typical English village with thatched roofs and beautiful flower gardens and old buildings covered with ivy.

The campus was in an old estate dating from 1300. The forest surrounding the old castle is a place of great beauty, with many trees more than 200 years old. Fine new buildings, permanent brick structures, were completed here in 1937 for the British Army and used as an officers' training school during the war. They needed little changes to turn them into our university classrooms and

dormitories. These efficient modern features contrasted startlingly with the old and picturesque. Our mess was in Beckett Hall, once the home of King John. While some G.I.'s at leisure fished in the castle moat, others inside dropped coins into juke boxes or coke machines.

Each weekend special trips for faculty and students were arranged, taking us by bus or train to Oxford, Bath, Bristol, London, Stratford-on-Avon (with matinee and evening performances of Shakespeare's plays at the beautiful Memorial Globe Theatre), Stonehenge, Salisbury, Bournemouth, Windsor Castle, Kew Gardens, etc., etc. Transportation being furnished by the University and the trips well planned, made it possible to see much of England in the short intervals as could have been done in no other way. The men were fortunate indeed who had this respite from Army routine in such beautiful surroundings, with opportunity to advance their education with practical courses and have these rich cultural experiences all at the same time.

To set up a university in Biarritz, France, it was necessary to requisition some 85 hotels and some 35 villas. Here we had 4000 students and a faculty of 275, ranging in age from 42 to 65 years. In the science section, of 51 teachers 39 were Ph.D.'s; most of the others were Army officers. There in southern France there was the advantage of fine climate, beautiful scenery along that picturesque shore with the snow-capped Pyrenees in the distance; and the luxurious surroundings of that resort city to restore mind and body. The courses

were conducted there in the same way, with the same credits given.

Both Universities closed when most of the American boys had been returned home, and I was sent to Germany, with headquarters at Frankfurt, as a lecturer on the Atomic Bomb. Giving some 90 lectures to more than 10,000 G.I.'s, we traveled by plane, rail or jeep and once in a "40 and 8." This work was rugged in spots, but very stimulating. Always we had the most responsive audiences—boys who were intelligent and eager for information. These "one-night stands" kept us constantly on the move and enabled me to see practically all of Germany not in the Russian zone.

Outside the cities, which are depressing, the country is still beautiful and in the Bavarian Alps one hardly feels the effects of war. I spent some time visiting German universities—what is left of them—going through their literature on atomic experiments, visiting I. G. Farben, and other plants, the salt mines, concentration camps, the War Trials at Nuremberg, etc.,

etc.—trips I am very glad to have made but which I should not care to repeat. Perhaps my most heart-warming experience was the lecture tour I made of the Dutch universities—again because of the responsive audiences of students. Cut off during those long years of occupation by the enemy, those men were so eager for news of scientific work in the civilized world, their appreciation was enormous and so very gratifying.

Most of these months overseas begins to assume the clouded aspect of a dream, some of it nightmarish. The enduring impressions, as at home, are made by the friends one finds—the homely peasant with whom one goes fishing, the fellow-scientist who speaks a different language but recognizes the same formulas, the boy who lingers after class to ask an eager question, the youngster who follows, begging for a chocolate bar. In any language, in any country, at any age, one recognizes friendliness. Friendliness gives meaning to life. The evidence of your friendliness on this occasion makes today one of the memorable days of my life.

### *Primitive Fish Poison Used Again*

► DERRIS, much-used insecticide ingredient, is put back to work at its original job as a fish poison by H. R. Siegler and H. W. Pillsbury of the New Hampshire Fish and Game Department. They use it in clearing ponds of undesirable fish species before restocking with trout or other

valuable game fish.

Derris was first brought to the attention of white men when European explorers found natives of the East Indies using the ground-up plants as an easy means for catching fish. Its value in killing insects was a subsequent discovery.

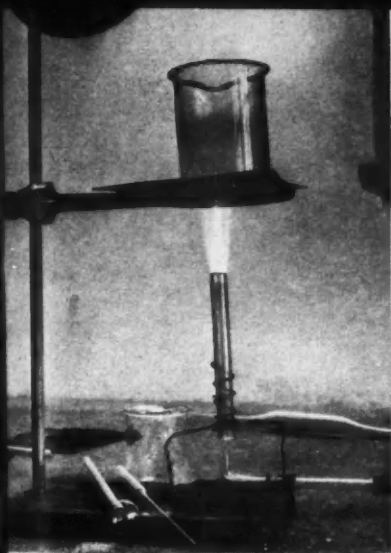
Fluorescent lamps generate about one-fourth as much heat as incandescent lamps.

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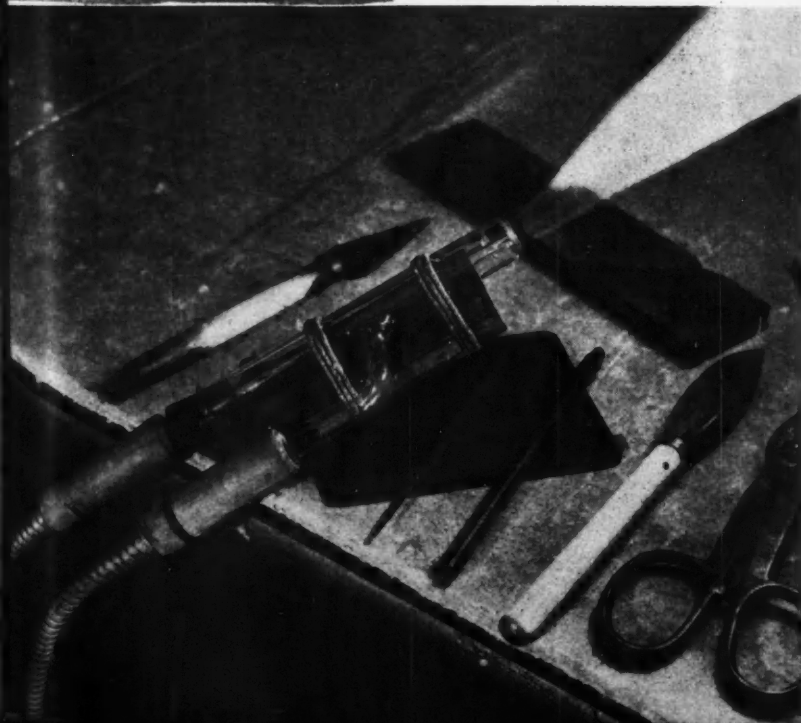


## Ingenious

**How laboratory apparatus was improvised by glass-blowing for Shrivvenham University for G.I.'s.**

► WHEN ONE is called upon to set up a modern chemical laboratory for which no equipment is to be had, it calls for ingenious adaptation of whatever materials happen to be at hand. Professor Ross A. Baker, now of the City College of New York, found himself in such a predicament when, toward the end of World War II, the Army decided to establish Army University Center No. 1, later called Shri-

*(Continued on page 34)*

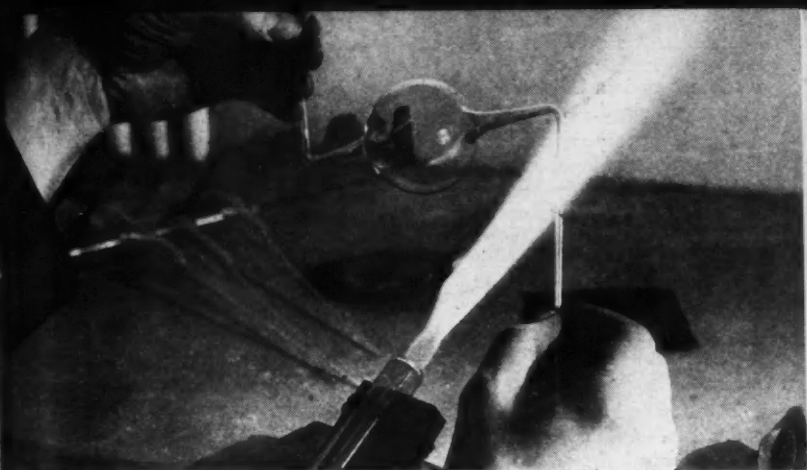




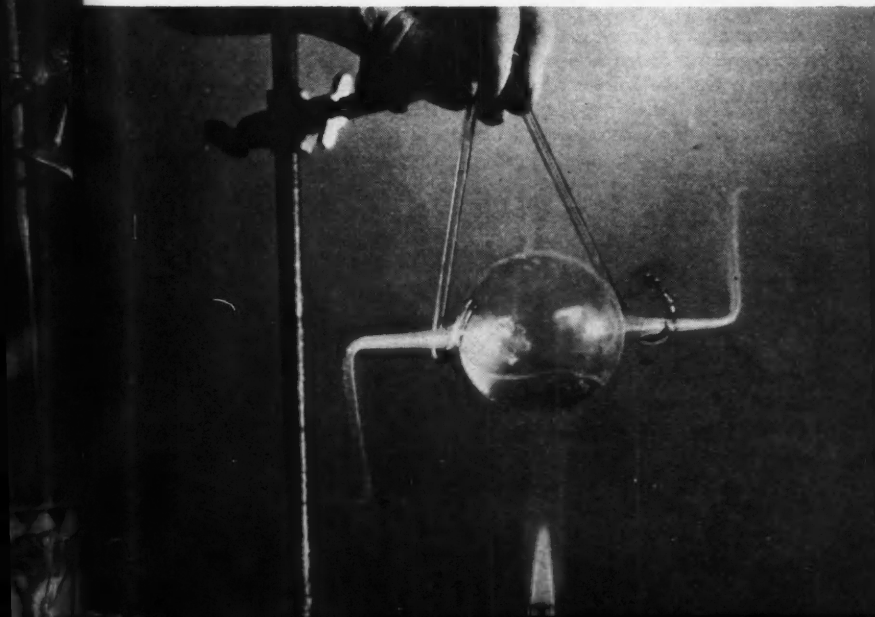
➤ *TO DEMONSTRATE the principle of jet propulsion, Dr. Ross A. Baker, Professor of Chemistry at the School of Business and Civic Administration, City College of New York, uses his improvised blow-torch to construct a Hero's engine. Four steps in the glass-blowing technique used in making the model are shown here.*



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► **ALTHOUGH THIS** demonstration of his principle was originally done for American G.I.'s in England, at the U. S. Army's Shrivenham American University, this Hero was not a veteran but an old Greek scientist who experimented with rudimentary steam engines and hit upon the jet propulsion idea, just now being put to practical use in advanced aircraft and rocket design.





venham American University, at Shri-venham, England.

The laboratory was a renovated kitchen, not unlike those shown in old illustrations of the workshops of pioneer chemists a century or more ago. The equipment was largely non-existent. To meet the need for Bunsen burners and blowpipes, well-known principles of their construction were worked out in unusual materials, with the successful results shown in these pictures.

The Bunsen burner is easily made, and cheap. A short length of glass tubing forms the barrel of the burner. A small knob of glass, melted and stuck to one side, allows the flame to be adjusted by screwing the tube into the spiral of wire which forms the holder.

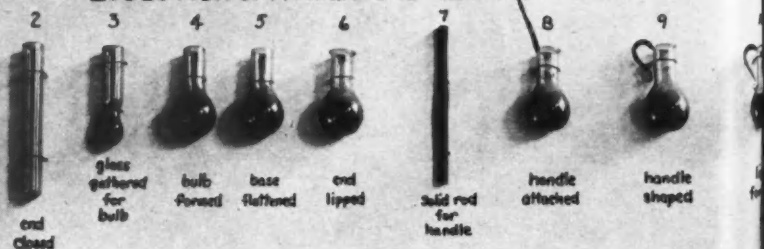
Another short piece of glass tubing is bent at the end and drawn out into a jet. This is held by the coil of wire

which forms the base and framework of the burner, as the picture shows. The force of the current of gas through the apparatus draws in air at the bottom of the barrel to give, with proper adjustment, the Bunsen burner's characteristic colorless, soot-free flame.

Prof. Baker, who has devoted his life to teaching chemistry, makes glass-blowing his hobby. Since a higher heat is necessary to blow glass successfully than can be obtained from the Bunsen burner, he next equipped himself with a blast lamp also made of glass tubing to burn gas with oxygen. The construction of the double tube, which is the essential part of this apparatus, is shown in the larger picture, accompanied by the glass-blower's simple tools. Since molten glass wets steel and sticks to it, copper and charcoal are the materials for tools that shape and handle the glass.

► *AMATEUR glass-blowers who would like to try their skill are offered this practice problem in ten easy stages, by Dr. Ross A. Baker, who taught glass-blowing to G.I. chemistry students overseas. The finished pitcher is about an inch tall. The handle is of black glass but the pitcher is transparent. Its dark appearance in the illustration is due to the cement which sticks it to the exhibit card.*

### EVOLUTION OF A MINIATURE GLASS PITCHER





With such equipment, Prof. Baker made quite elaborate pieces of lecture-demonstration apparatus to illustrate scientific principles for his G.I. University pupils.

### Hero's Engine

One demonstration which especially interested his audiences was adapted from a scientific toy worked out by the Greek philosopher Hero, who came near inventing a steam engine about the beginning of the Christian era. Hero's engine, although not harnessed to produce an appreciable amount of useful work, in its inventor's day, utilized the principle now known as jet propulsion, just coming into use now in rocket aircraft and missiles.

In his demonstration of the jet propulsion principle, Prof. Baker used a hollow glass ball with a tube extending from each side. The ends of the tube are bent and drawn out to make a narrow jet opening. When steam is

generated inside the ball, and the ball is suspended in such a way that it is free to rotate, the force of the steam escaping through the oppositely placed jets will maintain a rotating motion of the ball and provide an interesting illustration of the forces of action and reaction.

Starting with a piece of glass tubing with a bulge in the center, Prof. Baker, in the accompanying photographs by Fremont Davis, posed for CHEMISTRY, shows how he makes the apparatus by blowing the bulge out into a balloon and shaping the jet-arms. In the last picture he has filled the ball with water and hung it on a support that leaves it free to turn. When heating the water the ball must be kept turning by hand, to prevent overheating one side of the glass, which might cause it to break. But when the primitive little engine gets up steam it will take over the task of keeping itself in motion.

## Chemical Picks Up Water

► HOMES in humid climates may now be comfortable with a new chemical that picks up the moisture from the air. A few beads of the material in a salt shaker will keep the salt from caking. A handful in a toolbox will prevent rusting.

Its greatest value, however, is in industrial applications. It can maintain low humidity in warehouses, storerooms and holds of ships. Already it has been applied to ship protection. Air, dried with it, is pumped through pipes to vital parts of idle war vessels to keep machinery and equipment in condition. It has particular value

where grain, furs, textiles, lime and cement are stored.

The new material, technically a desiccant, is a product of Socony-Vacuum Oil Company, Inc., and has been named S/V Sovabead. It consists of spherical beads of uniform size. Each bead is honeycombed with microscopic pores that draw and hold moisture from the air, and is capable of adsorbing up to 40% of moisture. When saturated, it can be dried out by heating at 300 degrees Fahrenheit, and used over and over.

As compared with silica gel, the new material is more durable.

## Interference With Respiration Allows Fishes to Drown

# From Lack of Oxygen

by DR. FRANK THONE

► ISN'T IT ODD, that fish can drown?

Respiration in fish is basically the same as it is in land animals, a matter of getting oxygen into contact with the blood corpuscles which will in turn get into contact with the body tissues that need it. If that does not take place the animal dies, be it fish or be he man. Drowning is really a form of suffocation.

There are several ways in which fish can die for lack of oxygen. One is sheer mechanical interference with their normal mode of respiration, the ceaseless business of gulping water in through the mouth and expelling it through the gill slits. If a fish has a stick thrust through mouth and gills and is then dragged at abnormal speed through the water (as small boys often do), it will die, and it will die of drowning, that is, suffocation, because it could not "breathe" naturally.

A more wholesale extermination of fish through de-oxygenation of water takes place sometimes in summer, when fish that have been landlocked in a pond or lagoon find the water getting too warm, and at the same time swarming with fast-multiplying small forms of animal and plant life. Fish ordinarily do not live in a green stagnant pool because green water is

poisonous. It is because the myriads of lesser organisms living there snatch up every available molecule of oxygen for themselves, so that there is none left to pass through the gill walls and enrich the fishes' blood.

This kind of minor tragedy of the waters is relatively small-scale and unimportant, as compared with what the fish are often up against in rivers and lakes polluted by the outpourings of factories. Sometimes these pollutants are chemicals that directly poison the fish; much more often, however, they are things that the swarming bacterial life of inland waters can use for food. They do feed greedily, using up oxygen in the process, until again the turbid waters will not support fish respiration.

In considerable areas in the tropics, small lakes and sluggish rivers go nearly dry in the hot season, and have so little oxygen in their water at all times that ordinary fish cannot live in them. Their principal inhabitants are lung-fishes, strange creatures that have given up the use of gills entirely and depend on air sucked into their swimbladders which function as primitive lungs. When things get really bad, these fish sink to the bottom, ball themselves up into mud cocoons, and sleep the summer through as toads and turtles sleep through our winter.

Peanut protein fibers suitable for weaving into cloth were developed in England prior to the war and may be improved for commercial production.

**Catalytic Action of Iron  
As Told by Its Discoverer**

## Chapter From A Chemist's Life

*From the book THE LIFE OF A CHEMIST, Publication No. 21 in the Hoover Library on War, Revolution, and Peace, reprinted by permission. (Stanford University Press, 1946 —\$6.00)*

by VLADIMIR N. IPATIEFF

➤ AT THE BEGINNING of 1900 my most immediate worry was that I still had to write a text in chemistry for the Academy and School. My lectures at the Artillery School in inorganic chemistry differed so considerably from the existing texts that the sooner I could write my own the better. It seemed best to mimeograph it first and then publish it after making corrections. The first two-thirds of the course covered the laws of chemistry, valences, and the Periodic Law; and I described the halides of the fifth, sixth, and seventh groups of the periodic table, supplying sufficient material to indicate its great importance. By various examples I illustrated how this marvelous systematization, the periodic table, made chemistry easier and more understandable.

Before Sapozhnikov went abroad we had agreed to a joint publication of this course, and for this reason I left for his treatment the halides of the fourth group of the periodic table and the metals. If he had not informed me earlier that he intended to write a book similar to mine, I would have worked separately; but it would have been ridiculous to write two books for the same course. Hence, after several not too pleasant conferences, we agreed that each of us should write a certain portion of the text. In the second half of 1900 the

course was mimeographed and the cadets found their study of chemistry considerably helped.

A brief study of the part written by Sapozhnikov convinced me that it required serious revision before it could be published. This left me with the unpleasant and difficult task of convincing him that his chapters were essentially the same as those in existing textbooks and that in his part of the book he had failed to consider the first part of the course. We had several sessions discussing the changes that I thought should be made. It could not have been pleasant for him to listen to my criticisms, even if they were just. At length we agreed that after a complete revision of the whole course we would again discuss the matter and prepare a final edition. The book was published the following year.

The investigation which interested me most at the beginning of 1900 was the study of the addition of halogen acids in acetic solution to conjugated diolefins. Professor Thiele had shown that bromine added in a special way to these hydrocarbons. I planned to study the addition of hydrogen bromide to the simplest diene, butadiene; but it turned out that I could not begin this work until the following fall.

When my father-in-law died suddenly in 1896 he had left a very val-

uable apartment building in the center of Moscow (Brusovsky Lane) and a large piece of land to my wife and her brother, jointly. This was a great surprise to her and to everyone else; for it had always been assumed that her father would leave the bulk of his estate to his son. But her brother never gave the slightest sign that he had been disappointed. He was a kindly man, very fond of our children; and we were on the friendliest terms. Indeed, he may have been glad that I could help him manage the property. His retiring disposition and lack of business ability made it almost impossible for him to do such things, and it is very likely that if he had been sole owner he would simply have sold his property at considerable loss.

During this summer vacation he and I began the construction of a four-story apartment house on the vacant land. A property of this sort produced far more income than government bonds, and it would have been unforgivable to have left the land unused. Building some twenty apartments, we spent about 300,000 rubles (\$150,000). My uncle Gliky, my mother's brother, who lived in Moscow, agreed to manage the building and to supervise most of the construction.

In the fall I returned to my investigations and began to prepare butadiene in large quantities. At that time the only method of obtaining it described in the literature consisted in passing the vapors of isoamyl alcohol through a heated tube. The temperature was not specified, but it was apparently around 600° C. The gases containing a small percentage of buta-

diene were bubbled through bromine, giving solid butadiene tetrabromide and other bromides. Then the action of zinc and alcohol upon the solid bromide produced gaseous butadiene. Professor Thiele had used this method in preparing butadiene for his experiments on conjugated olefins, employing an iron tube for the pyrolysis instead of a quartz tube, since the former was more suitable for work at a high temperature. I found that in using this method the yield of butadiene was surprisingly small. I tried to discover the reason for this low yield, and I wondered if it might not be because of the polymerization of butadiene under the high temperature used.<sup>1</sup>

Up to this time no attention had been paid to the nature of the liquid products obtained in this reaction; probably most investigators assumed that they were water and undecomposed alcohol. I separated the other liquid products from the water, dried and distilled them, and discovered that the major constituent was isovaleric aldehyde, the remainder consisting of undecomposed isoamyl alcohol. This interesting observation made me surmise that the aldehyde was formed from the alcohol and that the gas should be largely hydrogen. The gas analysis completely substantiated this supposition and I decided to investigate this newly discovered reaction more thoroughly and to determine the conditions under which it took place. First I tested to see if the decomposition took place in glass or quartz tubes, and for the first time I intro-

<sup>1</sup>By polymerization is meant the condensation of a number of molecules into one.

duced a Le Chatelier pyrometer into the organic combustion furnace. I found that only the iron tubes decomposed alcohol at 500° C. into aldehyde, and that alcohol passed through glass and quartz tubes unchanged, unless the temperature was raised to more than 700° C. In glass and quartz tubes, also, the yield of aldehyde was smaller, and the gases contained, besides hydrogen, carbon monoxide, methane, and ethylene.

I immediately carried out similar experiments with ethyl alcohol as well as with secondary and tertiary alcohols, and found the following: all primary alcohols give aldehydes and hydrogen upon passage through an iron tube; secondary alcohols decompose into ketones and hydrogen; while tertiary alcohols yield neither aldehyde nor ketone but at a higher temperature decompose into the hydrocarbons and water.

Thus it became apparent that iron was a compound which caused the decomposition of alcohol without undergoing any change itself; in other words, it was a *catalyst*. The novelty of this discovery was such in that day, that when I told Professor Favorsky, he assured me that the aldehydes were formed not from the alcohol but from the ether, which was the first product

of the decomposition of alcohol. Later I proved that my theory was correct.

After making these experiments I searched the literature for material on the decomposition of alcohol and read the original articles of Saussure\*, Neumann\*\*, Berthelot, and others. The data obtained by those investigators were highly contradictory, and it was impossible to draw any definite conclusion concerning the mechanism of the reaction. Sometimes acetaldehyde was discovered in the products from ethyl alcohol, and sometimes it was not; and the gases were found to contain hydrogen, ethylene, carbon monoxide, carbon dioxide, methane.

I immediately wrote an article describing my preliminary experiments and my review of the literature, and reported my findings at the January meeting of the Russian Physical-Chemical Society in 1901. The report was entitled "Pyrogenetic Reactions of Organic Compounds." In it I showed for the first time the influence of the walls of a container on a reaction, and predicted that this would be very important in various industrial processes, especially in the so-called dry distillation of organic compounds (decomposition in the absence of air). The report created a great deal of interest among members of the society, and I was asked many questions.

\*SAUSSURE, HORACE BENEDICT DE (1740-1799). Swiss physicist and meteorologist; held the chair of experimental philosophy, University of Geneva, 1762- 1782; his *Voyages dans les Alpes*, 1779-1796, were valuable for the meteorological data recorded during his mountain-climbing; he invented perfections of the thermometer, anemometer, and electrometer, the hygrometer which bears his name, etc.

\*\*NEUMAN, FRANTZ ERNST (1798-1895). German physicist; took part in the War of 1815 and afterward studied at the Universities of Jena and Berlin; professor of physics and mineralogy at the University of Königsberg, 1828; established (1831) Neumann's law, that the molecular heat of a compound is equal to the sum of the atomic heats of its constituents.

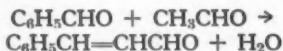
## For the Home Lab

# Fragrance of Cinnamon

by BURTON HAWK

► IN THE SOUTH SEA islands of the Pacific, in Asia, and in Ceylon, there grows a plant which yields valuable volatile oils, and which is known scientifically as *Cinnamomum zeylanicum*, or more commonly as cinnamon. The household spice is obtained from the dried bark of this plant which sometimes attains a height of twenty feet. Also, from the bark, leaves and twigs of the plant, there is derived an oil which is used in medicine and as a flavor in foods and in the manufacture of perfumes. But it is no longer necessary to travel to the South Sea Islands to obtain this delightful, tangy flavor, for the practical chemist has created a method of preparing the oil in his own laboratory. Having analyzed the natural oil as a mixture of aldehydes, acetates, acids and alcohols, he found it possible to synthesize the chief ingredient of the oil—*cinnamaldehyde*, which possesses a pleasant cinnamon odor. It can for most purposes be used as a substitute for the natural oil.

Cinnamaldehyde is formed by the action of dilute alkali solution on a mixture of acetaldehyde and benzaldehyde. This is an example of a *condensation* reaction, where two substances combine to form a third one with the resultant elimination of water:



The dilute alkali acts as the *condensing agent*.

Mix together in a large test tube 5 ml. of acetaldehyde and 5 ml. of benzaldehyde and add 4 ml. of dilute sodium hydroxide solution. Stopper tightly and shake thoroughly for three or four minutes. Then immerse the tube in a solution of cold water, preferably ice water. Continue to shake the mixture occasionally from time to time. Remember, in organic chemistry patience is a virtue. Since organic compounds do not form ions they are slow to react. After about an hour of the ice water treatment, allow the stoppered tube to stand in a cool place for at least twelve hours. At the end of this time a yellowish oily liquid will have formed in the test tube. Separate the oil by means of a separatory funnel or medicine dropper. Do you recognize the spicy odor?

While this experiment may appear relatively simple to perform, you may encounter some difficulty in obtaining the desired product. If such is the case, it may be that the component reagents used were not sufficiently pure. Therefore it is advisable to distill the acetaldehyde and benzaldehyde separately before using them in the experiment. Because of its inflammability and low boiling point, care must be exercised in the distillation of acetaldehyde. Place small quantities at a time in a flask which should be immersed in boiling water. Do not heat the flask with a direct flame. When distilling

benzaldehyde, add several pieces of clay plate or glass beads to prevent spurring and irregular boiling. Use both reagents immediately after distilling.

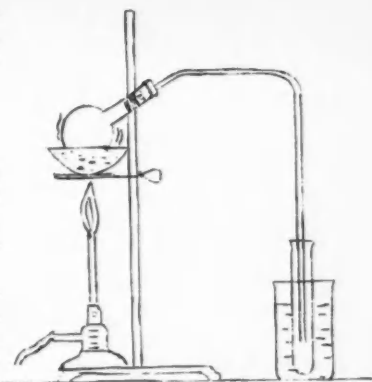
### Make Your Own Reagents

► IF A SUPPLY of acetaldehyde and benzaldehyde is not available, it is possible to prepare a sufficient quantity of each to perform the above experiment.

The preparation of benzaldehyde was discussed in detail in a previous article of this series. The method described is the destructive distillation of an intimate mixture of dry calcium benzoate and formate.

Acetaldehyde can be prepared by a similar method using a mixture of calcium acetate and formate. These two compounds are easily prepared by neutralizing the respective acids (acetic and formic) with calcium carbonate.

Acetaldehyde is an inflammable liquid, colorless when pure, with a boiling point of 21 deg. It has a pungent odor and should not be inhaled



DISTILLATION OF ACETALDEHYDE

too strongly as it irritates the mucous membranes. It is produced commercially from acetylene which reacts with water in the presence of dilute sulfuric acid and mercuric sulfate as catalyst:  $C_2H_2 + H_2O \rightarrow CH_3CHO$ . It can also be prepared by the oxidation of alcohol:



## Nuisances Find Many Uses

► ORGANIC PEROXIDES, formerly regarded as nuisances in petroleum, are finding valuable uses in jet-propulsion fuel and other industrial applications, according to Dr. Adalbert Farkas, Andrew I. Smith and Arthur F. Stribley, Jr., Union Oil Company of California.

They explain that the peroxides in petroleum previously discolored, gummed and lowered the octane number of gasoline, but processes for manufacturing them in virtually pure

form have opened up a new field for the peroxides.

From these "nuisances" have come plastics, insecticides, disinfectants and bleaching and oxidizing agents. Known as uniperox, the clear liquid is now added to some fuels to accelerate combustion and ignition.

Capable of converting low-grade fuel to high-grade, uniperox raises the octane number of diesel fuels and boasts the unique property of permitting easy starting at low temperatures.



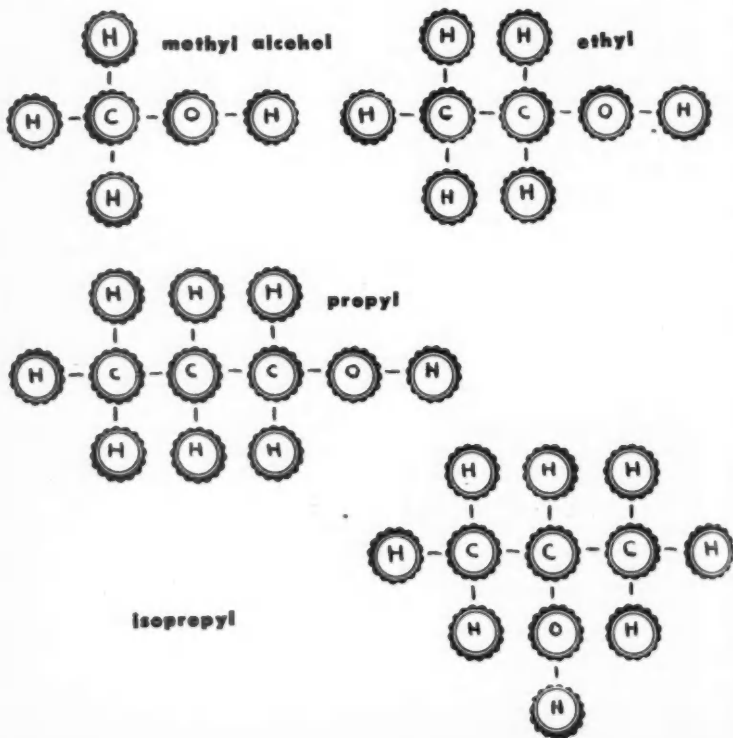
**Adjoining Carbon Atoms May  
Take On Different Radicals**

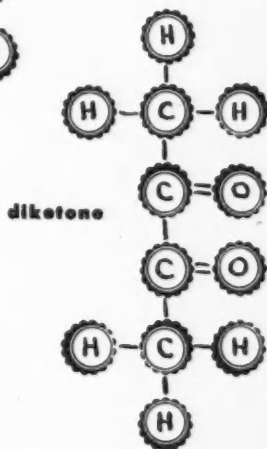
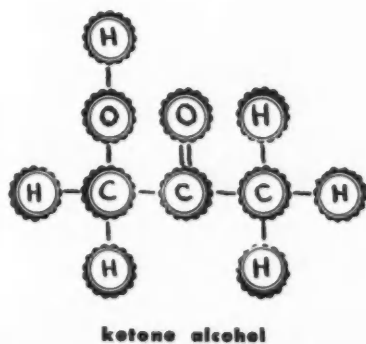
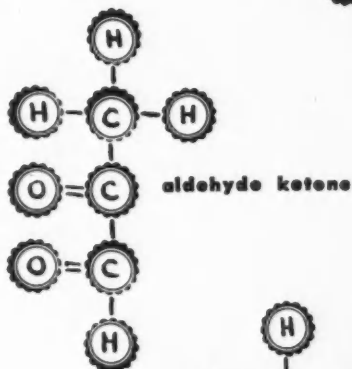
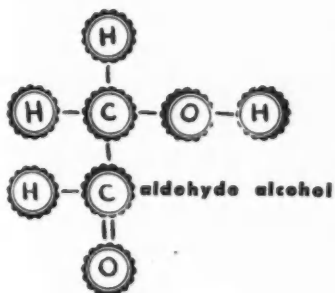
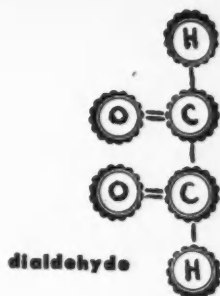
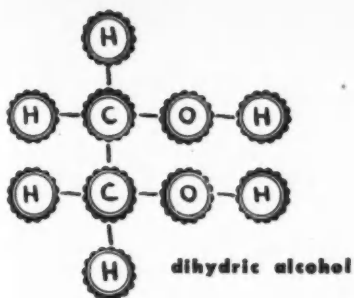
## How Organic Compounds Are Built

➤ AS THE NUMBER of carbon atoms in the molecule increases, the opportunities increase for forming mixed types of compounds. By using different reagents, different temperatures, different techniques, it is possible to induce quite unlike sorts of radicals to

join the various carbon atoms of the chain.

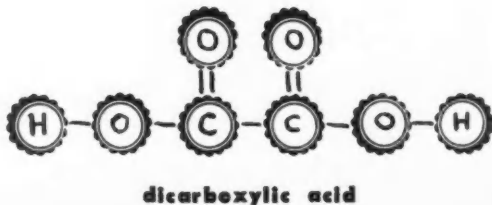
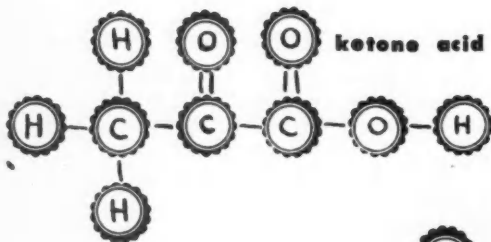
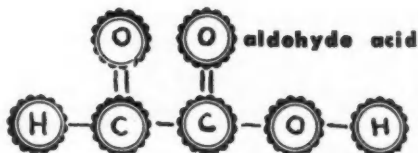
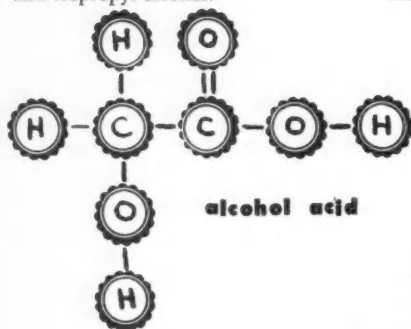
Beginning with the alcohols, one hydroxyl group at the end of the chain converts the hydrocarbon to the normal alcohol. Attached to a mid-chain carbon atom, the product is a dif-





ferent material, isomeric with the normal compound but with distinct properties. As the number of carbon atoms in the chain increases, the number of isomers increases rapidly. The beginning of this series of variations is shown here in the case of propyl and isopropyl alcohol.

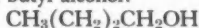
The designation primary, secondary, tertiary, etc. does not refer to the number of hydroxyl groups but to the position of a single group in reference to the carbon atoms of the chain. A primary alcohol is the normal form, with the OH group joined to the end carbon atom, which is con-



nected to only one other carbon atom of the chain.

The prefix *iso-* shows that the OH radical is joined to an inner carbon atom, which holds two carbon atoms by its other valence bonds. The arrangement of the secondary and tertiary alcohols is best shown by structural formulas, for example, of the butyl alcohols:

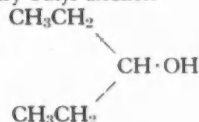
Normal butyl alcohol:



Isobutyl alcohol:



Secondary butyl alcohol:



Tertiary butyl alcohol:



Not only is it possible to get different materials by different arrangements of one radical substituting for hydrogen in the hydro-carbon molecule, the presence of two or more carbon atoms allows the same kind of radical to be attached to each of the carbon atoms in the molecule. For example, ethane can have a hydroxyl group joined to each of its carbon atoms, resulting in a double, or dihydric, alcohol, whose class name is glycol. Propane with a hydroxyl group off and the molecule rearranges itself.

cerol, whose -ol ending is intended to symbolize its structure as an alcohol. Non-chemists know the substance as glycerine. Having three hydroxyl groups, it is a trihydric alcohol.

Returning to the simpler dihydric alcohol, it is possible to put each of the hydroxyl groups separately through the oxidation reactions which result in the series of characteristic organic compounds. The ten combinations resulting from these separate modifications are pictured in this month's diagrams, with the simplest monohydric alcohols for comparison.

Those who like to work out permutation and combination problems may figure on the possible number of isomers for these various sorts of compounds as the number of carbon atoms in the chain goes up. But the chemist must not let mathematical possibilities run away with him. A chemical substance exists when it has been synthesized and its properties determined. It does not necessarily exist just because we can write its formula. On the other hand, many substances have been predicted on theoretical grounds long before they have been made in the laboratory. Also, real derivatives are known of substances which have only theoretical existence. This is particularly true of esters of certain organic acids. When the chemist tries to reconstitute the acid, water splits off and the molecule rearranges itself

#### Hydrocarbon

methane  $\text{CH}_4$

ethane  $\text{C}_2\text{H}_6$

propane  $\text{C}_3\text{H}_8$

butane  $\text{C}_4\text{H}_{10}$

pentane  $\text{C}_5\text{H}_{12}$

hexane  $\text{C}_6\text{H}_{14}$

#### monohydric alcohol

methyl alcohol  $\text{CH}_3\text{OH}$

ethyl alcohol  $\text{C}_2\text{H}_5\text{OH}$

propyl alcohol  $\text{C}_3\text{H}_7\text{OH}$

butyl alcohol  $\text{C}_4\text{H}_9\text{OH}$

amyl alcohol  $\text{C}_5\text{H}_{11}\text{OH}$

hexyl alcohol  $\text{C}_6\text{H}_{13}\text{OH}$

#### maximum OH groups

monohydric  $\text{CH}_3\text{OH}$

dihydric  $\text{C}_2\text{H}_4(\text{OH})_2$

trihydric  $\text{C}_3\text{H}_5(\text{OH})_3$

tetrahydric  $\text{C}_4\text{H}_6(\text{OH})_4$

pentahydric  $\text{C}_5\text{H}_7(\text{OH})_5$

hexahydric  $\text{C}_6\text{H}_8(\text{OH})_6$

## Patents in Chemical Fields

*Foods, metals and plastics are handled in new ways in the new crop of patents. Copies of patent specifications may be obtained for 25 cents (not in stamps) from the U. S. Commissioner of Patents, Washington 25, D. C. Order by patent number.*

### Two Temperature Refrigerator

► A TWO-TEMPERATURE refrigerator, with ice-cube freezer in a compartment entirely separated from the food-cooling section, promises greater ease and efficiency in tomorrow's house-keeping. It is covered by U.S. patent 2,405,392 issued to Leonard W. Atchison of Schenectady, N. Y.

The freezing compartment, at the top of the cabinet, receives full benefit of the mechanical refrigeration. The food compartment below, which is to be kept at a somewhat higher temperature—40 or 45 degrees Fahrenheit—has its own cooling coil, which is filled with a mixture of oil and an easily evaporated refrigerant of the Freon type. Extensions of this coil into the upper compartment are connected with a condenser that functions as a heat exchanger. When the lower compartment tends to heat up, some of the refrigerant in its coil evaporates. The vapor rises into the heat exchanger, where it is condensed and re-cooled, flowing back into the food-cooling coil. The process is thus one of extreme simplicity and fool-proof efficiency. Patent rights have been as-

signed to the General Electric Company.

### Simplified Ice Making Machine

► FOR FREEZING on a larger scale, to produce big cakes of ice, Arthur D. Smith of Canton, Ohio, has invented a machine for which he claims great economy both in initial capital investment and in operational labor. The water to be frozen is contained in a large drum or closed cylinder. Rotating within this is another drum, polygonal in cross-section, from the faces of which project long tubes, closed on their outer ends.

Within this rotating drum is the refrigerant, which runs down into the tubes as they are carried through the water, and out again as they reach the top of the turn. Ice forms on the tubes, each passage through the water adding a thin layer, until finally the separate masses coalesce into large solid blocks. Because of the constant stirring of the water, the ice is free of troublesome bubbles.

Rights in Mr. Smith's patent, No. 2,405,272, are assigned to the Barium Steel Corporation of Canton.

### Checks Gun Bores for Flaws

► A METHOD for examining the bores of rifles and small-caliber cannon for flaws is the subject of patent 2,405,245, obtained by Alexis E. Ushakoff of Beverly, Mass. He thrusts into the bore a long, slender rubber bag with a sheet of thermoplastic material wrap-

ped around it. Then he applies air pressure and at the same time heats the barrel until the plastic sets. After cooling, the bag is deflated, and the hollow plastic cast is withdrawn, bearing a negative imprint of every detail of the interior of the barrel. Patent rights are assigned to the United Shoe Machinery Corporation.

### **Solar Still**

► A PORTABLE STILL that uses solar energy for getting drinking water out of sea water, and can be rolled up compactly for stowage is the subject of patent 2,405,118, granted to W. R. P. Delano of Syosset, N. Y., and W. E. Meissner of Newark, N. J. Production of two quarts of fresh water a day is claimed for this device.

### **Improved Detonator**

► LEAD NITROAMINOGUANIDINE (LNAG for short) is now much used as detonator for industrial explosives. It gives off ammonia and deteriorates when stored in the presence of moisture. To obviate this, LeRoy V. Clark of New Castle, Pa., adds a small percentage of either the sulfate or the nitrate of copper, nickel or cobalt. Patent 2,405,189 was granted on this method.

### **Better Permanents**

► PERMANENT WAVES that do not require the hair to be soaked in a chemical solution while heat is applied are offered by a St. Paul, Minn., group consisting of R. E. Reed, David Tenenbaum and Marion Ben Beste, for patent 2,405,166. The hair is pre-conditioned by treatment with a solution of thiglycolic acid made alkaline with ammonia. This is rinsed out and the hair, moistened only with

water, is wound on the mandrels and heated until the wave "sets."

### **Peanut Proteins**

► TWO NEW FORMS of protein, good for making synthetic fabrics, adhesives and other manufactured products, can be extracted from peanut meal after oil extraction by a newly patented process developed at the U.S. Department of Agriculture's Southern Regional Research Laboratory in New Orleans. Previous methods of extraction have brought out all the proteins at once, and they have had to be separated in fractions good for different purposes—which of course involved additional chemical treatment and consequently greater cost.

In the new process, the meal is first treated with water containing caustic soda, with its hydrogen ion potential adjusted close to the neutral point. This brings about a total extraction of proteins. The remaining solids are centrifuged out.

Acid is added to the remaining clear liquid until the hydrogen ion potential is 6. At this point a white, semi-plastic precipitate is formed that can be pulled into filaments, ribbons or sheets showing a marked sheen or gloss. It has been named "protein 6". To the remaining clear liquid more acid is added until the hydrogen ion potential is 4.5. This brings out a second white solid, which is granular and non-sticky. This has been designated "protein 4.5."

The four-man team conducting this research, consisting of G. W. Irving, Jr., A. L. Merrifield, R. S. Burnett, and L. D. Parker, have assigned rights in the patent, No. 2,405,830, royalty-free to the government.

### Levels For Contouring

► A FARM MACHINE of great potential importance is the subject of patent 2,405,634, granted to C. H. Batterman of Gering, Nebr. It is a device for the guidance of the tractor driver who is trying to guide his furrows accurately along contour lines on sloping fields. It consists essentially of a very wide U-tube filled with liquid, with glass sections permitting the operator to see changes in level. This is carried on a truss frame, the rear end of which is attached to the front of the tractor, while the front end rides a three-wheeled truck or dolly.

### Carrier For Rice Fields

► ANOTHER FARM machine among newly patented inventions is a grain carrier designed especially for use in rice fields or on other soils too soft to support the weight of trucks. It is a cart with a hopper-like body, mounted on large-treaded rubber-tired wheels. Running upward from the bottom of the hopper is an adjustable elevator tube containing a spiral screw for unloading the grain. This is driven by a power takeoff from the towing vehicle. The inventor, Q. J. Aaberg of Angleton, Texas, has received patent 2,405,727.

### For Rocket Fuels

► PATENT 2,405,785 has been added to the already long series issued to the estate of the late Prof. R. H. Goddard of Clark University on combustion chambers for long-range rockets. An arrangement of concentric walls, the outer spaces serving for the pre-mixing of liquid fuel and liquid oxygen, keeps temperatures below the melting-point of the metals used.

### Powdered Oxides

► ALKALI METAL oxides, like potassium tetraoxide and sodium peroxide, are much used in industry, especially in respirators. To reproduce these cheaply in the finely divided form required, Carey B. Jackson of Forest Hills, Pa., blows air and melted metal through a nozzle having concentric passages into a reaction chamber having a removal hopper at its bottom. Rights in his patent, No. 2,405,580, are assigned to the Mine Safety Appliances Company of Pittsburgh.

Aluminum phosphates, also used extensively in industry, are prepared by a new method on which H. H. Greger of Washington, D. C., has obtained patent 2,405,884. He disperses finely divided aluminum hydrate and either phosphoric acid or phosphorus pentoxide in separate portions of kerosene, then mixes the two in the presence of water.

### Polymer Replaces Tin

► NATURAL GAS may be the means of freeing the United States from its present galling dependence on foreign sources of tin. Biggest use of tin, of course, is for coating sheet steel used in cans. A du Pont chemist, Milton J. Roedel, has invented a process for coating sheet metal with a solid polymer of ethylene, one of the constituents of natural gas, which is claimed to give at least as good protection as the conventional coating of tin.

The gaseous ethylene is turned into a solid suitable for coating purposes by subjecting it to very high pressures and moderately high temperatures. Dissolved in xylene and applied to black sheet steel in a layer one thousandth of an inch in thickness, then



baked on, the polymer coating is flexible enough to withstand the bendings and crimpings encountered in can manufacture, and has high resistance to both acids and abrasion.

Rights in Mr. Roedel's patent, No. 2,406,039, are assigned to E. I. du Pont de Nemours and Company.

### **Improved Antibiotic Production**

►FOR AN IMPROVEMENT in the production of the antibiotic tyrothricin, which will kill certain germs that escape penicillin, Dr. Jacob L. Stokes, bacteriologist with Merck and Company, has received patent 2,406,174, rights in which he has assigned to his employing firm.

Instead of culturing the producing organism, *Bacillus brevis*, in shallow containers of organic nutrients, Dr. Stokes uses the more economical deep culture, bubbling air through the fluid, which is a synthetic mixture of glucose, mineral salts, and one or more amino acids.

### **Meat "Floats Through The Air"**

►MEAT has always been a difficult problem in the relatively new food dehydration industry, primarily because those portions that come into contact with the metal trays or wire drums of conventional drying units are likely to be "overdone". To obviate this difficulty, William A. Noel, a U. S. Department of Agriculture engineer, has invented a meat-dehydrating machine in which the particles of ground meat are blown upward in a blast of hot air and kept dancing about in contact with nothing solid at all until the drying process is complete.

Fat, tried out in liquid form during the process, finds its way into a col-

lecting duct at the bottom and is saved separately. When the lean part of the meat is well dehydrated, it is blown over into a cyclone separator, where it is whirled down to the bottom and drawn off for packing.

U. S. patent 2,406,395, issued on this machine, has been assigned to the government.

### **Steamed Dried Onions**

►ONE QUITE SPECIALIZED phase of food dehydrating is represented in patent 2,406,431, granted to Martha W. Miller of Vacaville, Calif. Onions and garlic can be dehydrated successfully, but tend to become quite brittle in the process; and in these vegetables too-small pieces are undesirable. Mrs. Miller has discovered that this brittleness can be overcome by a light steaming process after the drying is completed. After this, the dehydrated material can be pressed into bricks for marketing without the use of a binder.

### **Gauge Measures Dustiness**

►DUSTINESS of the air, a matter of vital importance in many industries, as well as to human health and comfort, can be measured by a new and simple gauge devised by H. W. Sheridan of Oak Park, Ill., which received patent 2,406,409. It consists of a case containing a sinuous air passage, through which the air to be tested is drawn. At the end of one long, straight arm of the air passage is a window into which a beam of light is projected. At right angles to this axis is a second window, opposite which is a photocell connected to a graduated dial. Dustless air will reflect no light through this window, dusty air a good deal. The dial reading tells the difference.

## Wartime Inventions Patented

► TWO WARTIME inventions are subjects of recent patents. One is a recoilless mortar, in which part of the powder blast is expended through vents in the enlarged breech chamber, to offset the backward push of the barrel. This is the invention of M. H. Gohmann of Dearborn, Mich., and is covered by patent 2,406,537.

The second is a multiple-stage rocket, designed with an eye to easy and economical manufacture by standard machining processes, invented by Winslow B. Pope of Detroit, for patent 2,406,560. Both of the foregoing patents are assigned to the government.

## Peat Fuel Drying

► A THREE-STAGE tower-drying process for the improvement of peat fuel is offered by a Swedish inventor, Claes-Wilhelm Pilo of Stockholm, for patent 2,406,509. Water is dried out in the first two stages; in the third the dried peat is carbonized, ready for compressing into briquets.

## Brazing Beryllium

► BRAZING BERYLLIUM onto other metals to make vacuum-tight joints for X-ray apparatus is the subject of patent 2,406,310, issued to George J. Agule of Stamford, Conn. The process

is carried on in a vacuum, the heat coming from a high-frequency coil.

## Rubber Antioxidant

► IMPROVEMENT in antioxidants that prevent rapid deterioration of rubber is claimed by John R. Vincent of Wilmington, Del., in patent 2,406,722, assigned to E. I. du Pont de Nemours and Company. He uses a secondary aromatic amine as the oxidant, and boosts its efficiency with a phthalocyanine, or with a phthalocyanine compound with a metal.

## Casein From Seeds

► AN ENGLISH CHEMIST, R. L. Wormell, of Coventry, has received patent 2,406,650 on a method for extracting casein from seeds that contain it, such as soybeans and peanuts. It consists in first treating the ground-up seeds with an alkali to dissolve the casein out, then precipitating it with acetone.

## Cross-Eyed Microscope

► A BINOCULAR MICROSCOPE that can be made more or less "cross-eyed" by turning knurled knobs on the sides of its housing gives the operator the benefit of any degree of stereoscopic vision needed for the examination of his specimen. The inventors, A. H. Bennett of Kenmore, N. Y., and O. W. Richards of Snyder, N. Y., have assigned their patent, No. 2,406,526, to the American Optical Company.

## Butadiene By-Product

► EXPERIMENTS to improve fuel gas used in American homes helped produce a needed war chemical.

An experimental plant of the United Gas Improvement Company of Philadelphia, built to study petroleum con-

stituents placed in city gas, produced about 6000 tons of butadiene, an important ingredient of synthetic rubber. The plant was one of the first in this country to make this chemical, and its operation was continued during the war at governmental request.

**Water-proof, Fire-proof,  
Shrink-proof, Non-run**

## Engineered Fabrics

*Reprinted from the Industrial Bulletin of Arthur D. Little, Inc.*

★ FABRICS are being designed more and more with built-in characteristics for specific uses. Much of the current development in the design of fabrics stems from research sponsored by the Quartermaster Corps to meet military requirements, and involves the use of synthetic resins and other chemicals. Profitable production of engineered fabrics will require extensive industrial cooperation; the textile processor must be educated in many of the techniques of the chemical industry.

The fabric improvement most desired by the consumer is one that will prevent shrinkage. A recent survey revealed that 80 per cent of department store buyers ask for washable wool. The Army saved over \$1,500,000 a month by shrinkage control of woolen socks for soldiers. The extra cost of shrinkproof fabrics to the individual consumer is only a small part of the price.

Wool is believed to shrink, at least in part, because, once the fibers are drawn together mechanically when wet, the scales on the fibers prevent their being pulled apart again. One method of shrinkproofing involves treating the surface of the fiber with resin to prevent the scales from catching on each other. Cotton shrinkage is not thoroughly understood either, but one theory is that its water-swollen walls collapse as the moisture

content decreases; by filling up the fiber's hollow core with resin while the fiber is swollen, the collapse is prevented, but the external appearance of the fiber is unchanged.

The most common resins for shrinkproofing cotton and synthetics are the urea and melamine formaldehyde compounds. A process has recently been announced for treating rayon fabrics with glyoxal, a synthetic chemical, to stabilize them against shrinkage and stretch. For wool, the melamine resins are preferred because they reduce felting of the fibers and thereby preserve the open weave of the natural wool, even after it is washed. This makes possible a light fabric in which "dead-air" spaces prevail. Garments made from such material are lightweight and cool in summer, since they allow evaporation and insulate the body from the greater heat outside, yet they are warm without excessive weight in winter.

Resin treatment of spun rayon fabrics also reduces their tendency to wrinkle and crease; this treatment is widely used in the industry today. More work has been done on crease-proofing fabrics in England, however, than in the United States. It has been estimated that 90 per cent of English rayon fabric is now crease-resistant, as compared with only 20 per cent in this country. The English climate no

doubt has been an important factor in this development.

Sometimes "outer" impregnation of the fiber is sufficient, especially in fabrics where stiffness is desirable, such as glazed chintz or organdie. For this purpose, permanent finishes have been developed to replace non-durable finishes like starch. Glazed chintz which can be washed, and sheer fabrics which remain crisp for their entire life, will be on the market as soon as the textile situation eases. If current work is successful, even ironing will be eliminated, a boon to housewives who want ruffled curtains.

Pigment-resin dyeing has been accepted practice by the Army for fabrics for use in parachutes, mosquito netting, camouflage strips, etc., since 1939, although it has not completely replaced vat dyeing. The various processes have been improved during the past few years, and are now well adapted for light colors. Since heat curing makes the resin insoluble and results in fast colors, and since the process speeds up the printing and dyeing of fabrics, it is expected to be used to a greater extent in the future.

Many other chemicals are being developed to impart special properties to fabrics. Chlorinated paraffins, ammonium sulfamate, and antimony oxides are used for flameproofing; copper naphthenate, chlorinated phenols, mercurial compounds, and organic fungicidal compounds for mildewproofing. Moth protection may be obtained for the life of an article with compounds permanently anchored in the fabric. Silica derivatives, which increase the frictional resistance between fibers, are now on the market.

Applied to women's stockings, for instance, these compounds reportedly will decrease runs, since the yarn is not twisted as much for the same tensile strength and the friction prevents the stitches from slipping. Used with cotton yarns, they permit production of a softer, more bulky fabric with less material.

There are many materials to make fabrics water repellent; the older ones, such as metal salts or wax emulsions, must be applied whenever the garment is laundered or dry cleaned. Newer compounds, classified as ammonium salts, break down on heating to other products which are said to be substantially permanent, in that they withstand laundering and dry cleaning for some time. Another new compound, a silicon derivative, which may be applied in gaseous or other forms, is said to resist normal washing and dry cleaning. The gaseous treatment, however, evolves hydrogen chloride, which must be removed to avoid tenderizing the fiber.

A recently-announced process permits the use of shorter staple cotton fibers hitherto considered unsuitable for textiles, and is said to result in a fabric as strong as one using higher grade cotton and conventional methods. The short fibers are placed under equal and controlled tension, so that each individual fiber bears a portion of the load. By impregnating the fibers with resin so that they lock while curing, without the usual twist, a strong, firm yarn is produced, suitable for canvas, rope, and other heavy-duty applications. Other processes involve mixtures of short cotton fibers with resins or heat-softening resin fibers.

Heat treating causes the resin fibers to lock with the natural ones to form a heavy, strong yarn.

All the resin processes require a great deal of expensive equipment. Drying and curing chambers alone cost about 30 to 40 thousand dollars. Rayon finishing plants are now generally so equipped, but many other branches of the industry are not. The

transition stage is a difficult one for the textile manufacturer, because the choice of suitable resins and proper curing of them are crucial operations. Since each treatment has its individual characteristics, the choice of a particular treatment and the establishment of a treating routine pose greater problems for the textile industry than does use of the traditional finishes.

## *German Buna Rubber Lagged*

► THE GERMAN rubber industry, post-war investigations by American scientists reveal, had not progressed relatively as far as the American rubber industry in the use of their Buna type synthetic rubbers, Earl W. Glen of the U. S. Civilian Production Administration told scientists attending a meeting of the Society of Automotive Engineers. And this in spite of German pioneering work on synthetic rubber during the prewar years.

This particular session of the SAE was designated as a German Engineering Evaluation meeting, given largely to reports by specialists on technical matters concerning German automotive war equipment and such accessories as tires, fuels and lubricants. An exhibit of German military and automotive vehicles featured the meeting.

The backwardness in the German synthetic rubber program was attributed by Mr. Glen, whose permanent position is with the Goodyear Tire and Rubber Company, to a lack of cooperation between the synthetic production industry and the manufacturing companies using the prod-

uct. This situation changed rapidly as Germany prepared for war, he said, but the opportunity for close cooperation in the development of better synthetics on a production scale was lost and the industry was obliged to accept existing materials just when it was necessary to go into large-scale production as Germany mobilized for war.

Tire and rubber goods manufacturers were very critical of the Buna rubber they were forced to use. Under pressure from them, I. G. Farbenindustrie developed Buna S-3, he said, which eliminated some of the production difficulties and improved the performance of rubber products, particularly tires. The development of Koresin for compounding with synthetic rubber to improve the tackiness facilitated tire and mechanical goods production.

German equipment for brass-plating metal goods to facilitate bonding synthetics to track blocks and bogie rollers was excellent, Mr. Glen stated. An improved method of bonding these articles was in process of development in the I. G. Farbenindus-

trie laboratories at Leverkusen "wherein a coating of a new chemical called Desmodur R could be applied more efficiently than brass plating and produced a more uniform and satisfactory bond." Desmodur R was also used as a tire cord dip and general tackifier in the German tire industry.

Luka Reifen and Draftband Reifen

were interesting German developments. The first was a tire unit with a cellular solid rubber filler which was claimed to be very successful in operation without air. The Draftband Reifen was a tire without a steel base band, using bead wire embedded in a bevelled hard-rubber base as the surface to mount on a bevelled split rim.

## Gold-Germanium Alloy

► A LOW-MELTING gold alloy with several other unusual properties was described at a meeting of the American Institute of Mining and Metallurgical Engineers by Dr. Robert I. Jaffee of the Battelle Memorial Institute, Columbus, Ohio, where the alloy has been recently studied.

It is a gold-germanium alloy, 88% gold and 12% germanium. The latter is one of the less known metallic elements, but it is mined in the United States and is considerably cheaper than gold. The alloy melts at 673 degrees Fahrenheit, only 50 degrees higher than the melting point of lead. It is what scientists call a gold-germanium "eutectic," a term applied to an alloy with a lower fusing point than its components have by themselves. Gold melts at 1945 degrees Fahrenheit, and germanium at approximately 1760 degrees.

This eutectic is harder than ordinary gold alloys and has superior wearing qualities. These properties make it of value in jewelry. Another property of the alloy, Dr. Jaffee stated, is its slight expansion on solidification, which compensates for contraction in cooling to room temperature.

Because of this property, he said, extremely precise castings, such as dental inlays, can be made, and these dental castings would require no correction to take care of shrinkage that occurs with most alloys.

Because of the low melting point of the alloy, it can be used as a solder by jewelers doing repair work on gold jewelry. They can obtain the necessary heat to melt it with a common gas flame. Gold-coated jewelry of long-wearing properties can be made by merely dipping the object to be plated into the molten eutectic.

This gold-germanium alloy is not entirely new to metallurgists. It was first mentioned in an obscure German publication, Dr. Jaffee said. But Battelle Institute has been conducting experiments with it to determine its best uses. The chief interest in the metal at the present, he stated, is its potentialities as a rectifier in radar equipment.

Germanium is produced as a by-product in the production of cadmium. It resembles silicon in appearance and is closely related to silicon in nature, he explained. It was first discovered by a German scientist in

1886, but little thought was given to its utilization until recent years. The U. S. Bureau of Mines states that germanium is a crystalline gray-white metal, with chemical properties intermediate between those of silicon and

tin. While far from being abundant, germanium can be recovered in rather large quantities in the form of its oxide, as a by-product of zinc. Dr. Jaffee stated that about a ton a year is produced in America.

## *Titanium Compounds Substitute for Mica*

► THE LITTLE-KNOWN though widely used metal titanium, whose oxide has become one of the most important white pigments in paints, has new possibilities in the electric field, Eugene Wainer of the Titanium Alloy Manufacturing Co., Buffalo, told scientists at the meeting of the Electrochemical Society in Birmingham, Alabama, recently. Certain of its compounds, he said, are suitable as substitutes for condenser grade mica and for other dielectrics.

The electrical properties of titanium compounds, he asserted, indicate the suitability of these materials not only as substitutes for condenser grade mica but also for a number of other electrical applications where it is not possible or convenient to use other dielectrics. Such widespread application is possible through the variables

that can be introduced in a synthetically prepared product. The most important application, he added, is that involving high capacity at radio frequency.

The dielectric properties of titanium compounds have been studied by several scientists. The dielectric constant of the rutile form of titanium dioxide was first measured in 1902, he said. A German patent appearing in 1925 covered the use of titanium dioxide as a high frequency dielectric. Now, however, in view of the possibility of variables in any synthetically prepared construction as afforded by chemical and ceramics procedures, a correspondingly wide and controlled variation of electrical properties not feasible with structures of natural origin is made possible.

## *Cheaper Alcohol from Ethylene*

► CHEAPER ALCOHOL is made in a modern scientific way from ethylene, the American Institute of Chemical Engineers meeting was told.

Industrial ethyl alcohol has always been prepared by the ancient method of fermentation, but synthetic plants are replacing the sugar, starches, and blackstrap molasses with ethylene, prepared by petroleum cracking oper-

ations. Ethyl ether, the anesthetic, is prepared in the same process.

The ethylene is absorbed in sulfuric acid to make sulfates which are hydrolyzed to crude alcohol and a by-product of ethyl ether, C. M. Beamer of the Standard Oil Company of New Jersey reported. The alcohol is refined by distillation to produce industrial alcohol and ether of high quality.



## New Jobs for Chemists

► New jobs in the chemical industries are predictable from economic studies, according to Dr. L. W. Bass, Director of Chemical Research of Air Reduction Company and U. S. Industrial Chemicals, Inc., New York.

A new technical job is created in the plastics and synthetic resin field for each 200 tons additional manufacturing capacity. In the petroleum field, each increase of 200,000 barrels in the amount of crude going to the refinery means another position has been opened for some technically trained person, not including the jobs opened at the same time for unskilled help.

"Salaries of chemical engineers show a wide spread between high and low figures, a characteristic of professional earnings," Dr. Bass went on to say, "and salaries also increase with length of experience."

"In 1943, 10% of the chemical en-

gineers, 4.5 years after graduation, were earning more than \$364 a month and 90% were receiving more than \$217, the median salary being \$275," Dr. Bass reported. "In that same year, 25% of the engineers with 28.5 years of experience were paid more than \$902 a month, 75% were earning more than \$444, and the median salary for this group was \$629 a month.

"Eighty-three percent of the chemical engineers are employed by private firms. The Federal government employs 5.6% and the State governments 2.4%. The oil industry employs 15.7% of the chemical engineers. This field is one of the major source of employment for the profession.

"There will be expanding opportunities in other industries, such as foods, textiles, and leather, which now do not have many chemical engineers. The versatility of the profession is a valuable asset in such lines of manufacture."

## Answers to Chem Quiz on Page 24

► IT IS LATER than you think, and some of the elements just getting famous have been around quite a while. Here is the correct list of dates announcing the discoveries of elements now in the news.

1735—Platinum  
1755—Magnesium  
1766—Hydrogen  
1771—Fluorine  
1774—Chlorine  
1789—Uranium  
1797—Chromium  
1803—Cerium  
1811—Iodine  
1823—Silicon

1827—Aluminum  
1828—Thorium  
1828—Bromine  
1868—Helium  
1885—Praseodymium  
1898—Radium  
1898—Neon  
1922—Hafnium  
1942—Plutonium  
1945—Curium

Scandinavia. Home of Rare Earths.  
Frequently Honored in Their Names

## Elements Yielded by Yttrium

### A Classic of Chemistry

► THE RARE EARTHS are a group of metals first recognized as their oxides, whence the name "earths." At the time they were first investigated, chemical theory was in a very undeveloped state. Some investigators thought that what we now know as the oxides might be the uncombined state of an element. Analytical technique developed as chemists worked on the puzzling minerals which yielded one new element after another, and the constitution of their compounds became familiar. But the elements themselves remained a mystery on account of the great similarity of their salts.

As Classics of Chemistry, the discovery of Yttrium by Gadolin in 1796 and Cerium by Klaproth in Berlin and independently by Berzelius and Hisinger in Stockholm in 1804 appeared in this magazine in March, 1946, reprinted in the form in which

they were originally announced. In September, 1946, the Classic reprinted the account of how Mosander split Yttrium into Erbium and Terbium, and Cerium into Lanthanum and Didymium, in 1843.

The present Classic of Chemistry gives the accounts of the next steps in unravelling the rare earth minerals. Marignac split Erbium and identified Ytterbium, completing the quartet of elements named for Ytterby, the Swedish town where the first of the rare earth minerals was found. Cleve discovered two more elements in the Erbium fraction, to which he gave the Scandinavian names of Thulium and Holmium. And in the Cerium mineral complex, Lecoq de Boisbaudran found some new spectrum lines later identified as the new element Samarium, named from the mineral they were found in.

### Ytterbium

ON YTTERBINE, a New Earth Contained in Gadolinite. Note by M. C. Marignac. In *COMPTES RENDUS*, Tome 87, Paris, 1878.

► AS A RESULT of the researches which I have made upon the earths from gadolinite, researches which had for their object and which have for their result the confirmation of observations by M. Delafontaine upon the existence

of terbium and of a new base belonging to the same group, to which he gave the name *philippine*, I have obtained a few grams of an earth presenting all the characteristics which belong to erbium, following the classic work of MM. Bahr and Bunsen and of MM. Cleve and Hoglund.

I ought to state however that the process by which I separated it from

## Unconfirmed Elements

<i>Date</i>	<i>Name</i>	<i>Discoverer</i>	<i>Decision</i>
1811	Junonium	T. Thomson	error
1818	Vestium	L. W. Gilbert	unverified
1851	Donarium	C. Bergemann	mixture
1862	Wasmium	J. F. Bahr	mixture
1878	Mosandium	J. L. Smith	mixture
1878	Philippium	M. Delafontaine	mixture
1878	Decipium	M. Delafontaine	mixture
1884	Rogarium	J. L. Smith	mixture
1886	Austrum	E. Linnemann	impure gallium
1887	Russium	K. von Chrustchoff	mixture
1892	Masrium	H. D. Richmond	unverified
1894	Demonium	H. E. Rowland	dysprosium
1896	Damarium	K. Lauer and P. Antsch	unverified
1896	Lucium	P. Barrière	mixture
1896	Kosmium	B. Kosmann	mixture
1898	Monium	W. Crookes	victorium
1899	Victorium	W. Crookes	mixture
1901	Euxenium	K. A. Hotmann	unverified
1904	Carolinium	C. Baskerville	unverified
1904	Berzelium	C. Baskerville	unverified
1905	Incognitum	W. Crookes	terbium-gadolinium
1905	Ionium	W. Crookes	terbium-gadolinium
1907	Aldebaranum	C. A. von Welsbach	neoytterbium
1907	Cassiopeium	C. A. von Welsbach	lutecium
1911	Celtium	G. Urbain	lutecium
1916	Denebium	J. M. Eder	unconfirmed
1916	Dubhium	J. M. Eder	unconfirmed
1917	Eurosamarium	J. M. Eder	unconfirmed
1920	Welsium	J. M. Eder	unconfirmed

the other earths of gadolinite is not absolutely identical with that which those chemists used. Bunsen's process consists of heating the mixed nitrates until red vapor appears, redissolving in boiling water and separating out the nitrite rich in erbium which precipitates in small needle-shaped crystals upon cooling the solution. As for me, I was able to carry the decomposition of the nitrates much further, up to the

moment that the mass became sticky. Upon treating the mass with boiling water, there remains an insoluble residue in which the erbium is concentrated. By one or the other of these processes, repeated a very great number of times, we end by obtaining an earth of a pure rose color, which is erbium.

In my first researches, I stopped the treatment as soon as I arrived at a

rose colored earth whose equivalent weight, lying between 128 and 129, corresponded to that which has been assigned to erbine.

More recently, I have again taken up the products thus obtained, as I wished to assure myself whether, by continuing these same operations, I should obtain any further increase in the equivalent weight. Instead, I observed a fact which surprised me very much.

Whereas, in the first part of my work, the gradual increase of the equivalent weight corresponds to a deepening in intensity of the rose color and of the absorption bands characteristic of erbine, there came a time when, the equivalent weight continuing to increase slowly, the rose color and the absorption lines diminished quite rapidly, so much so that the last product obtained was perfectly white, its salts colorless, and no longer giving the absorption lines.

The last three products obtained gave the equivalent weights 130.4,

130.6 and 130.8. The first two still showed a sensible rose color, especially in the oxalate and sulphate crystals. The number 131 can be set approximately as the limit of equivalent weight which may be reached, if one can operate upon a sufficient quantity of material to carry this method of purification far enough.

It is evident from this that the earth which I extracted from gadolinite, and which I believed to be erbine, was only a mixture of two distinct oxides. One, a pure rose color presenting a very characteristic absorption spectrum, ought to keep the name *erbine*, since these are the characteristics which have been considered as more distinctive of that base. The other is a new base, belonging to the same group, and for it I propose the name *ytterbine*, which will recall its presence in the mineral from Ytterby, and its similarity to yttria, on the one hand, by its lack of color, to erbine, on the other, by the magnitude of its equivalent weight, with both of them by the whole of its properties. . . .

## Erbine Divided

ON TWO NEW ELEMENTS IN ERBINE, Note by M. P. T. Cleve. In *COMPTES RENDUS, Paris, 1879*.

► TOWARD the end of last year, M. Marignac discovered in erbine, till then considered an oxide of a single metal erbium, the oxide of a new metal, ytterbine, very strongly characterized. A short time afterward, M. Nilson found in erbine another oxide, scandine, whose salts are colorless like those of ytterbine. The substance which gives to the salts of erbine the red color and their beau-

tiful absorption spectra, that is to say, the true erbine, is still unknown. I proposed to extract from the old erbine its coloring principle. I had at my disposal a considerable quantity of material almost entirely free from ytterbine; M. Nilson very kindly gave me his precious residues from the extraction of scandine and ytterbine: nevertheless I found it absolutely impossible to obtain a red oxide of constant molecular weight, even after hundreds of decompositions.

I have been driven, since then, to

postulate the presence of still another unknown new oxide, so I asked M. Thalen to examine the absorption spectrum of the fraction which I regard as most pure in erbine, and at the same time to compare that spectrum with spectra of residues rich in ytterbine and yttria. Some absorption bands in the last fractions suggested the idea that the color of erbine is due to the presence of three oxides in the absorption spectra. I therefore combined the redder fractions, of molecular weight 126 to 127 (RO), and submitted them to a long series of decompositions, treating one fraction (A) or ytterbine, another (B) for yttria, and a third intermediate between them in which the true erbine ought to become concentrated. At the same time, I tried to concentrate the coloring matter in the residues rich in ytterbine (A) and in yttria (B). When I had pushed the decompositions until obliged to stop for lack of material, I sent the five fractions for examination by M. Thalen, who had the kindness to study them with great care. . . .

We see then that the (absorption) band  $x$  pertains to fractions situated near ytterbine, and that it does not exist in the fractions which derive from yttrium. But it is just the opposite with bands  $y$  and  $z$ ; in fact, these bands, which lack everything found in the residues of ytterbine, appear more and more pure, in proportion as they approach yttrium.

It appears from these researches that the spectrum of the old erbine ought to be attributed to three distinct ox-

ides. In fact, the color of the solutions of the diverse fractions is sensibly different. Thus the fractions treated for ytterbine are colored rose with a tint of violet, the fractions treated for yttria have an orange tint. Although I have a considerable quantity of the mixture of these three oxides, I am convinced that it will be useless to continue these researches until I am able to get still more.

As for the radical of the oxide occurring between ytterbine and erbine, which is characterized by the band  $x$  in the red part of the spectrum, I propose the name thulium, derived from Thule, the earliest name of Scandinavia. The atomic weight of the metal Tm ought to be about 113 (its oxide being RO); at least, its oxide is concentrated in the fractions which have the molecular weight 129.

The true erbium, to which the common bands should be attributed, probably has an atomic weight of 110 to 111. Its oxide is of a clear rose color.

The third metal, characterized by the bands  $y$  and  $z$ , which is found between erbine and terbine, ought to have an atomic weight lower than 108. Its oxide appears to be yellow; at least, all the fractions of molecular weight lower than 126 are more or less yellow. I propose for this metal the name of holmium, Ho, derived from the latinized name of Stockholm, in whose vicinity occur so many minerals rich in yttria.

It remains to tender M. Thalen my lively appreciation of the trouble which he has taken with all these researches.

## Samarium

NEW SPECTRUM RAYS OBSERVED IN MATERIAL EXTRACTED FROM SAMARSKITE *Note by Lecoq de Boisbaudran. In COMPTES RENDUS, Vol. 88, p. 322. February 17, 1879.*

► IN EXAMINING with the spectroscope, both by absorption and by means of the electric spark, the products of my work upon the mixture of earths from samarskite (rich in didymium), I observed lines or bands not related to any formerly known body and not corresponding to the descriptions of spectrum lines of earths recently announced by Messrs. Delafontaine, L. Smith, Soret and de Marignac.

The new lines of emission and those of absorption appear to correspond (at least the principal ones) to a single substance, for they follow similar variations of intensity in the series of products obtained by fractional crystallization.

*Emission Spectrum*—It is composed especially of four bands shaded toward the left, formed of narrow lines of which the strongest is the most refrangible and constitutes the right-hand border of the band. The approximate positions of the right-hand

edges of the bands are at the wavelengths (?)

*Absorption spectrum*—It has two strong bands in the blue and many lines of less importance in the green. . .

These two strong blue bands are seen very easily, either by gas light or by that of the sun.

The metal which gives rise to these new spectra is precipitated in the state of double potassium sulphate, at the same time as didymium; its simple sulphate is a little less soluble than that of didymium; its oxalate precipitates before that of didymium; finally, ammonia separates first the oxide of the new substance, then didymium oxide. All these reactions have to be repeated a great number of times if we wish to get a complete separation. . . .

Awaiting further verification, my two blue absorption bands and my four emission bands seem therefore to indicate the existence of a substance hitherto unknown. I hope soon in a measure to be able to confirm this supposition or to correct certain points in the description of the spectrum of decipium.

## Who's Who in This Month's Classic

JEAN CHARLES GALISSARD DE MARIGNAC (1817-1894) was a Swiss chemist, educated in Paris, later Professor of Chemistry at the Academy of Geneva. He played a prominent part in the discovery of several of the rare earths.

PER TEODOR CLEVE (1840-1905) was a Swedish geologist and chemist, Pro-

fessor at Upsala and the leading exponent of chemical research in Sweden in his time.

PAUL EMILE FRANCOIS LECOQ DE BOISBAUDRAN (1838-1912) was a French chemist who worked with the rare earths and spectroscopy. He discovered Gallium in 1875, Samarium in 1879 and Dysprosium in 1886.

## Hints For the Chem Lab

► PREPARING a good chemistry club demonstration requires contact with real equipment and proficiency in lab techniques, and provides a challenging opportunity for creative thinking and doing.

Often apparatus is limited, serves manifold uses and most times isn't available when desired for club use. The versatile chemistry club may construct many types of apparatus that may also be used in the regular chemistry classroom.

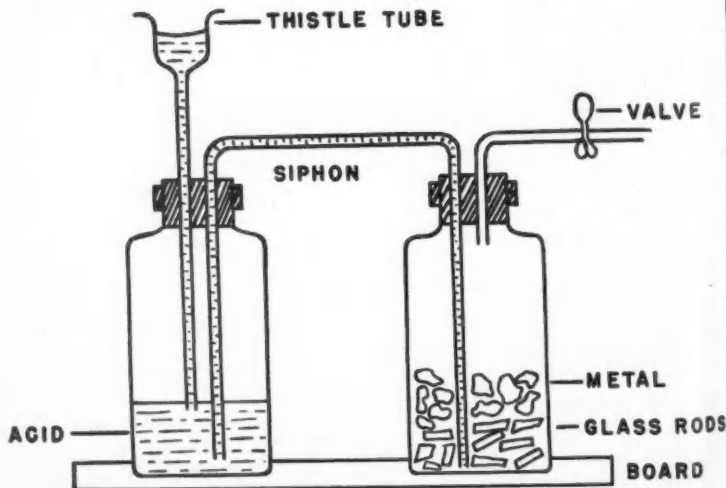
### Simple Gas Generator

A Kipp generator is typical of the apparatus usually difficult to obtain for chemistry club use. Often it is available, more often, it is loaded for

delivery of other than the desired gas.

Ingenious club members, using a few wide mouth bottles and other common pieces of chemistry lab apparatus, may construct a serviceable gas generator, similar to the one illustrated below, utilizing the principle of the Kipp generator. A few of these portable generators may be made and kept on hand, each for a different gas.

The connecting tube, with the longer end in the generator bottle, acts as a siphon. A pinchcock or glass stopcock is used as a valve. A thistle tube is arranged high enough so that when the generator is closed, a small amount of acid still remains in the tube. This "head" provides quick action upon







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BACK FROM THE WARS and back on the job are most of the Corning Field Research and Service men. Right now they are undergoing a "refresher course" here at the factory brushing up on all the new developments while they were away. Soon, however, they will be out on the road—calling on users of "Pyrex," "Vycor" and "Corning" Laboratory Glassware.

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opening the valve. Small pieces of glass rods, about one inch in length, are placed in the generator bottle, about one inch in depth. These permit quick drainage of the acid from the metal when the reaction stops. For convenience in carrying the apparatus, the bottles are placed in holes gouged out with an expansion bit on a thick piece of board.

When the valve is opened, acid siphons over into the generator bottle and reacts with the metal. As soon as the valve is closed, the pressure of gas forces the acid back and the reaction stops.

Service to the school can be the keynote of the progressive chemistry club because it assists the busy club sponsor in many ways. Here are a few hints for club members.

#### **Crucible Rack**

Porcelain crucibles if not handled with care are easily broken. Club

members can construct a simple rack which will prove very useful for storage of crucibles.

Cut a board to fit inside the lab desk drawer so snugly that it will not move or jar when the drawer is opened. Glue to this board several corks of such diameter as to fit the base of the crucible. These must be short enough to permit the crucible to rest flat on the board.

#### **Retouching Scale Lines**

Chemistry students know how tiresome it is to read scale lines on thermometers, pipettes, burettes and other graduated glassware which have lost their colored markings and are difficult to read.

This situation may be easily corrected by simply taking a wax glass marking pencil and rubbing the etched lines until they are filled in. The excess is then wiped off with a piece of cloth and the apparatus is as readable as when it was new.

### *Drop Us a Hint*

*The editors of CHEMISTRY plan to publish "Hints for the Chem Lab" from time to time. All scientific groups work together and make known their findings for the common good. "Hints" that have served you well may serve others.*

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